Title: PSI 2018/2019 - Programming in Phyton - Lecture 2

Date: Aug 27, 2018 10:30 AM

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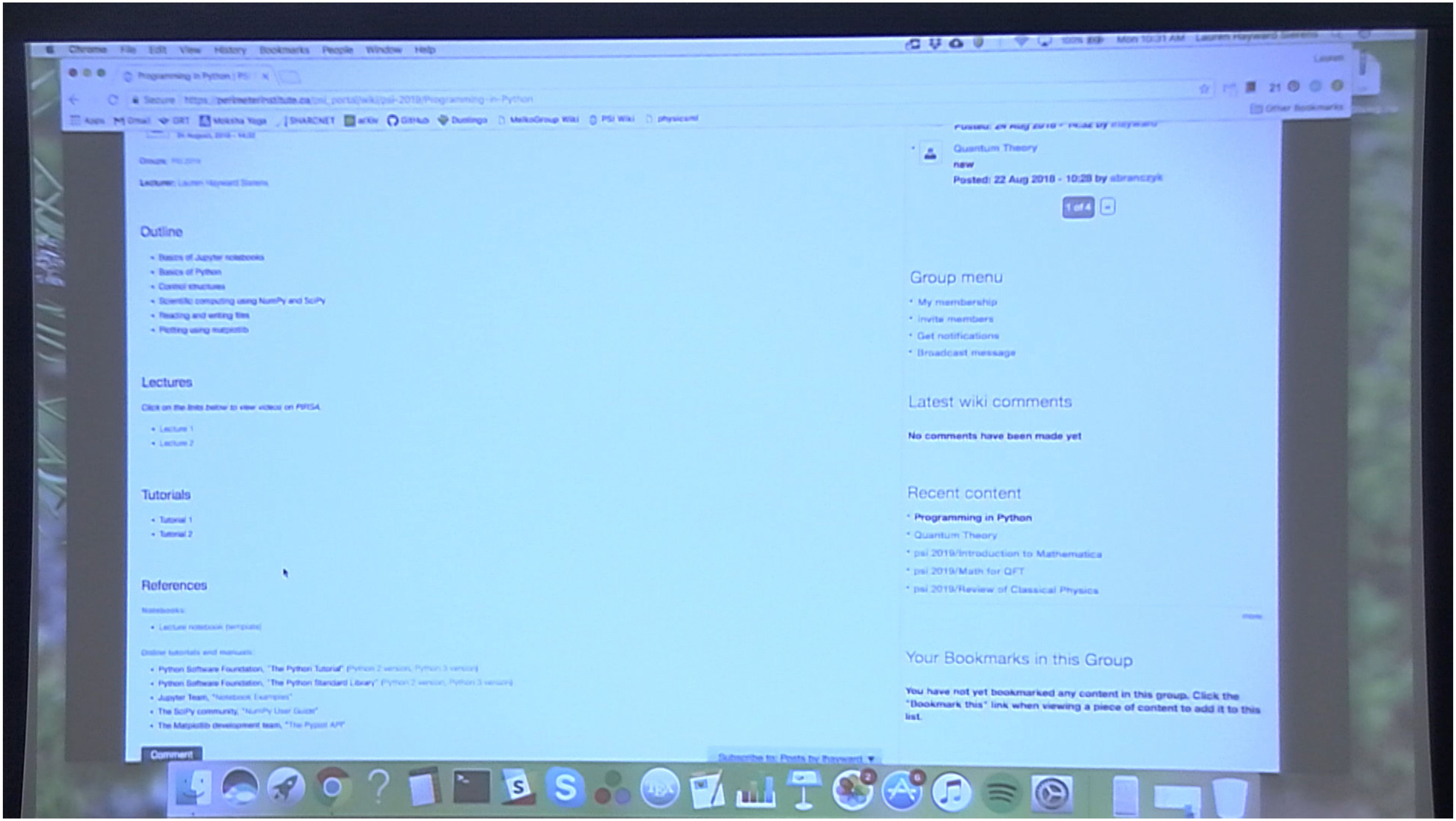
Abstract:


Programming in Python
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Basics of Jupyter notebooks
Basics of Python
Control structures
Scientific computing using NumPy and SciPy
Reading and writing files
Plotting using matplotlib
Lectures
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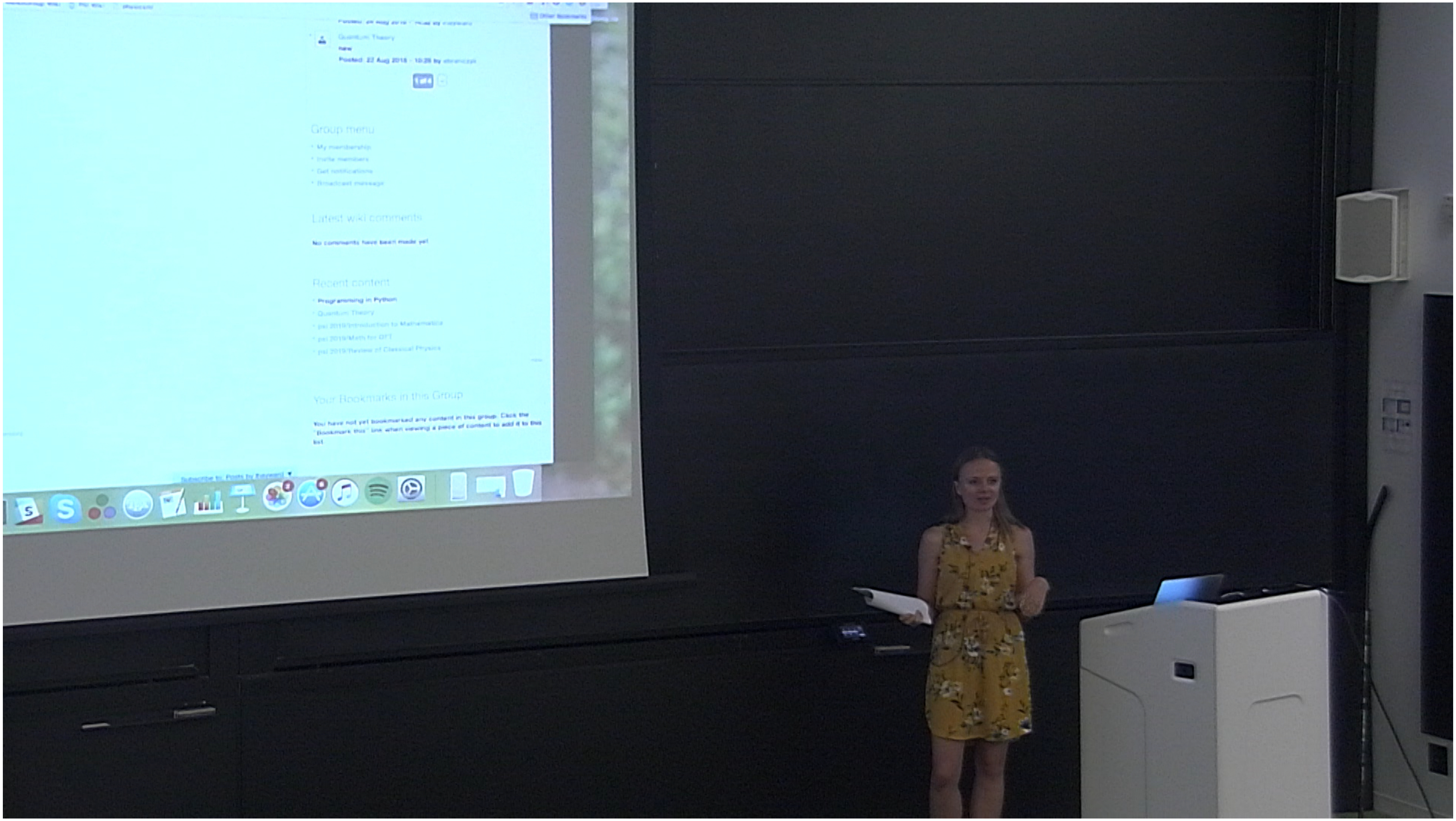

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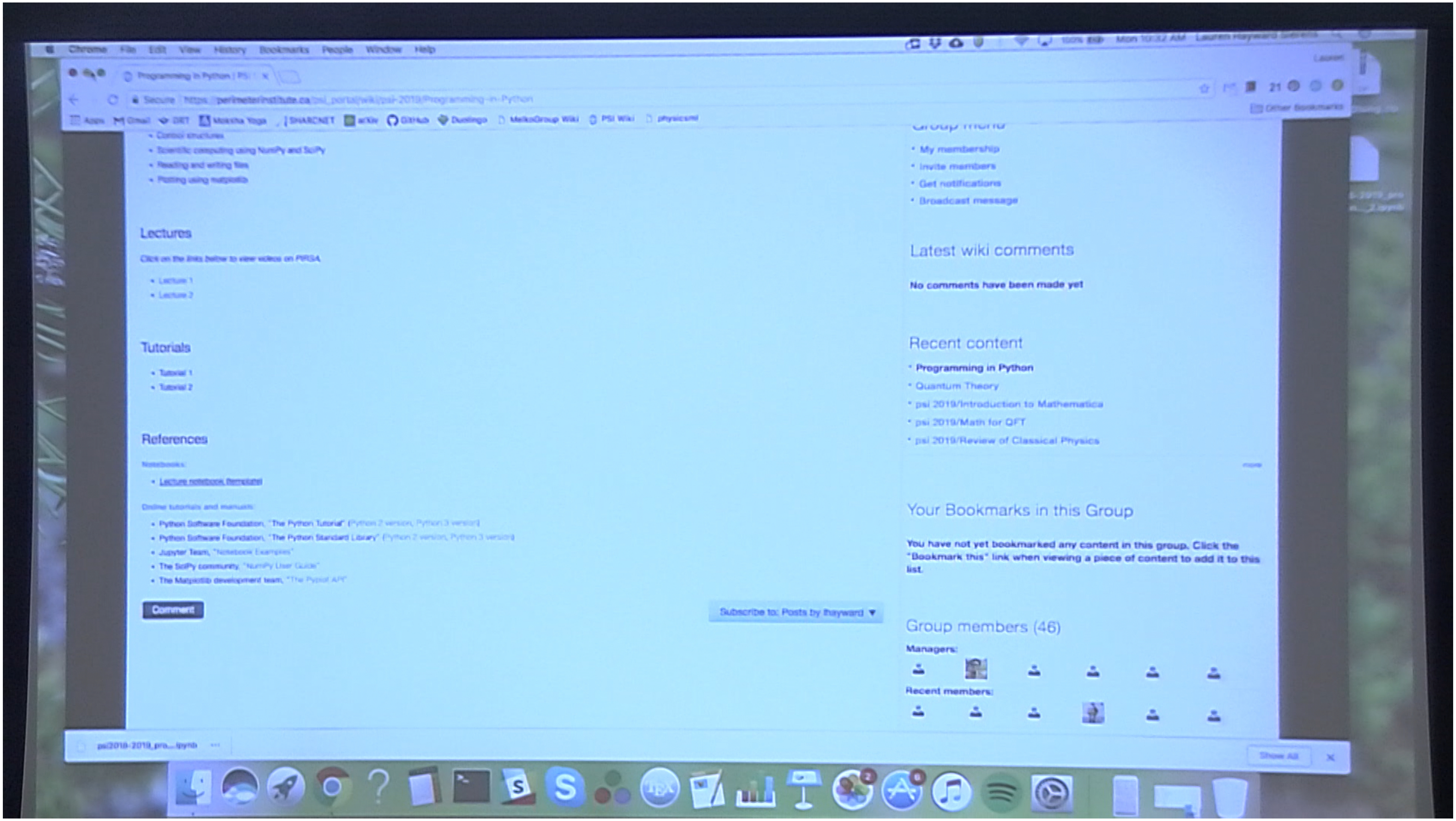

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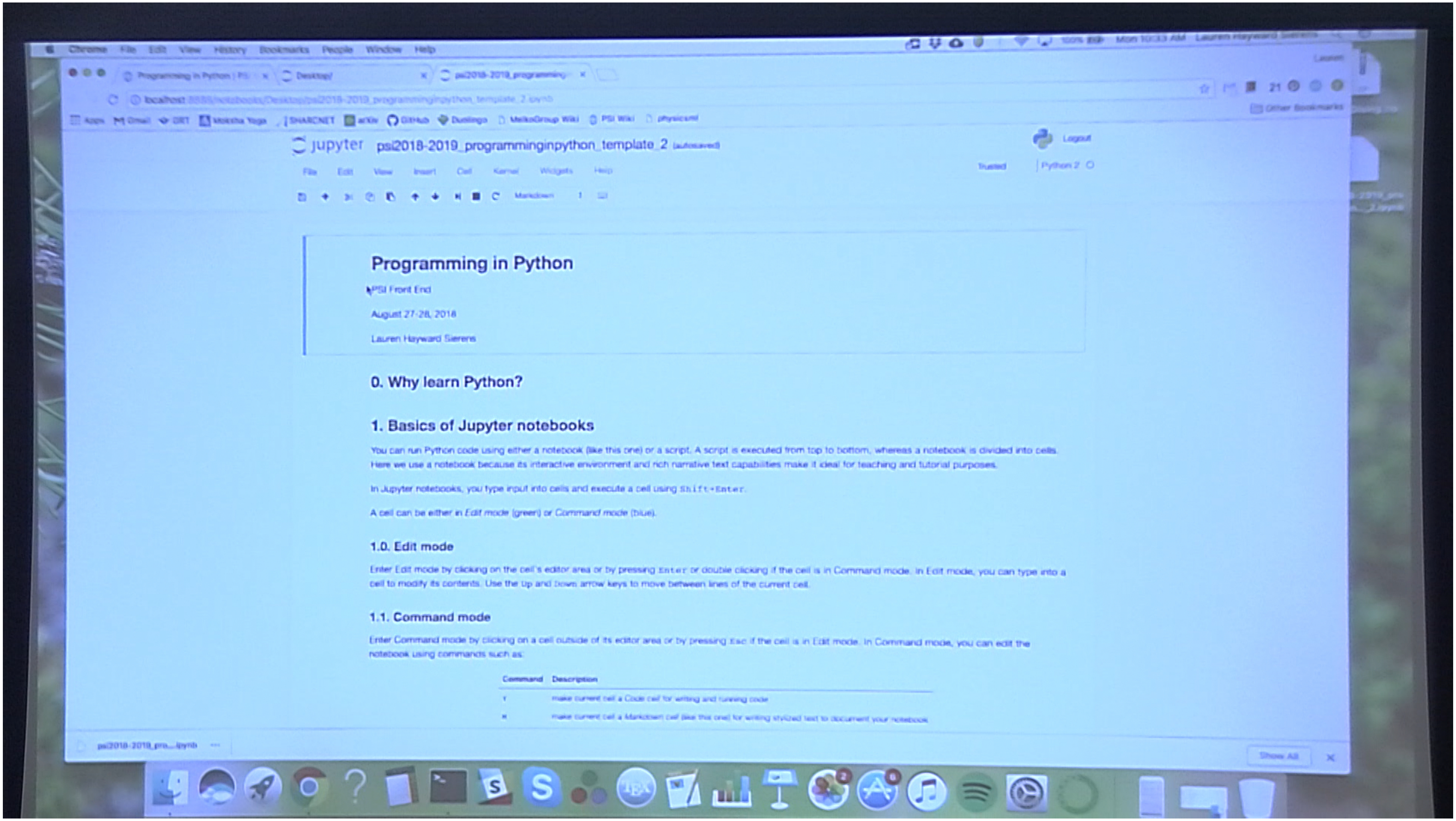
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Programming in Python
PSI Front End
August 27-28, 2018
Lauren Hayward Sierens
0. Why learn Python?
1. Basics of Jupyter notebooks
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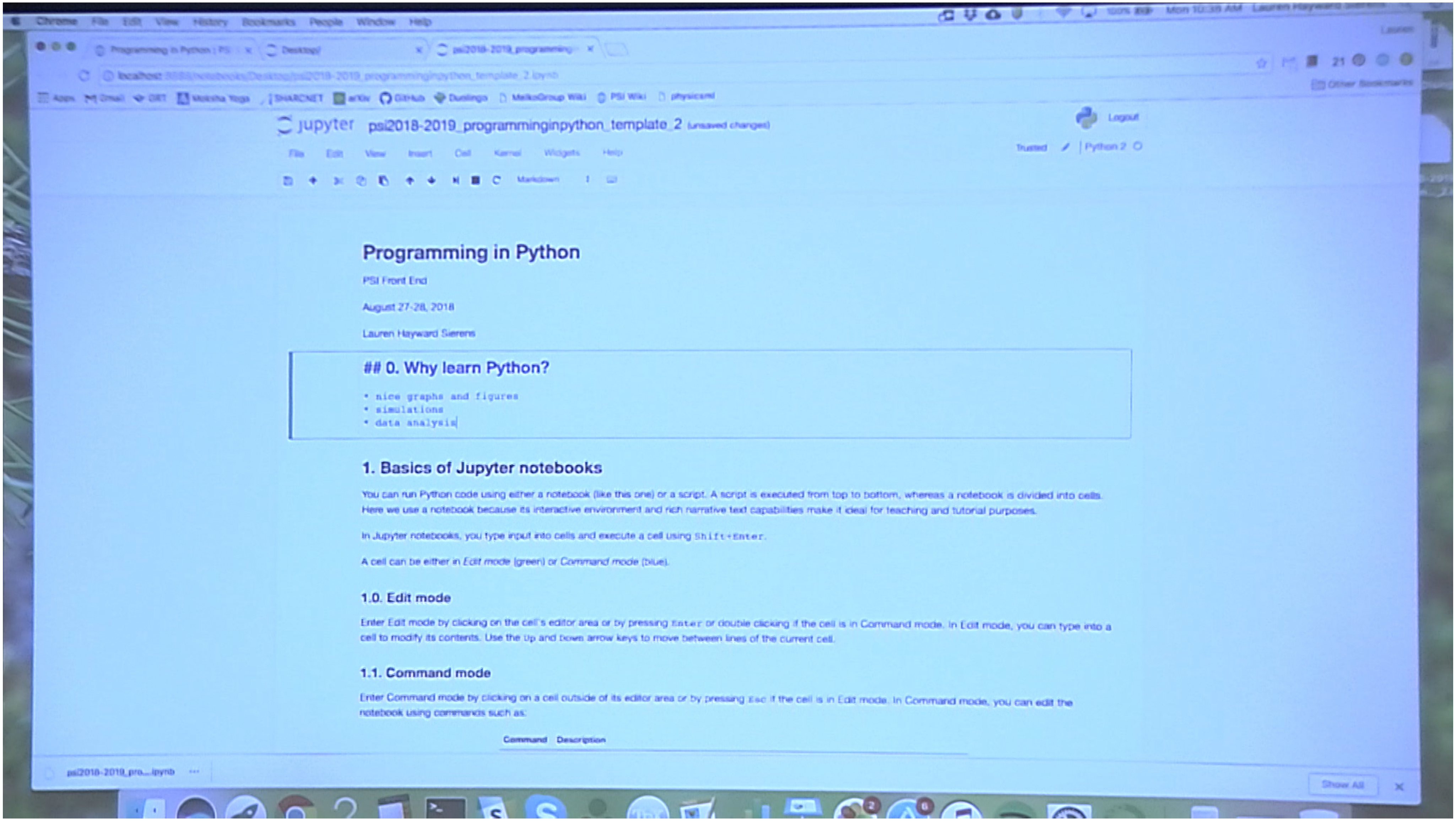
Command
Description
y
make current cell a Code cell for writing and running code
m
make current cell a Markdown cell (like this one) for writing stylized text to document your notebook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• simulations
• data analysis
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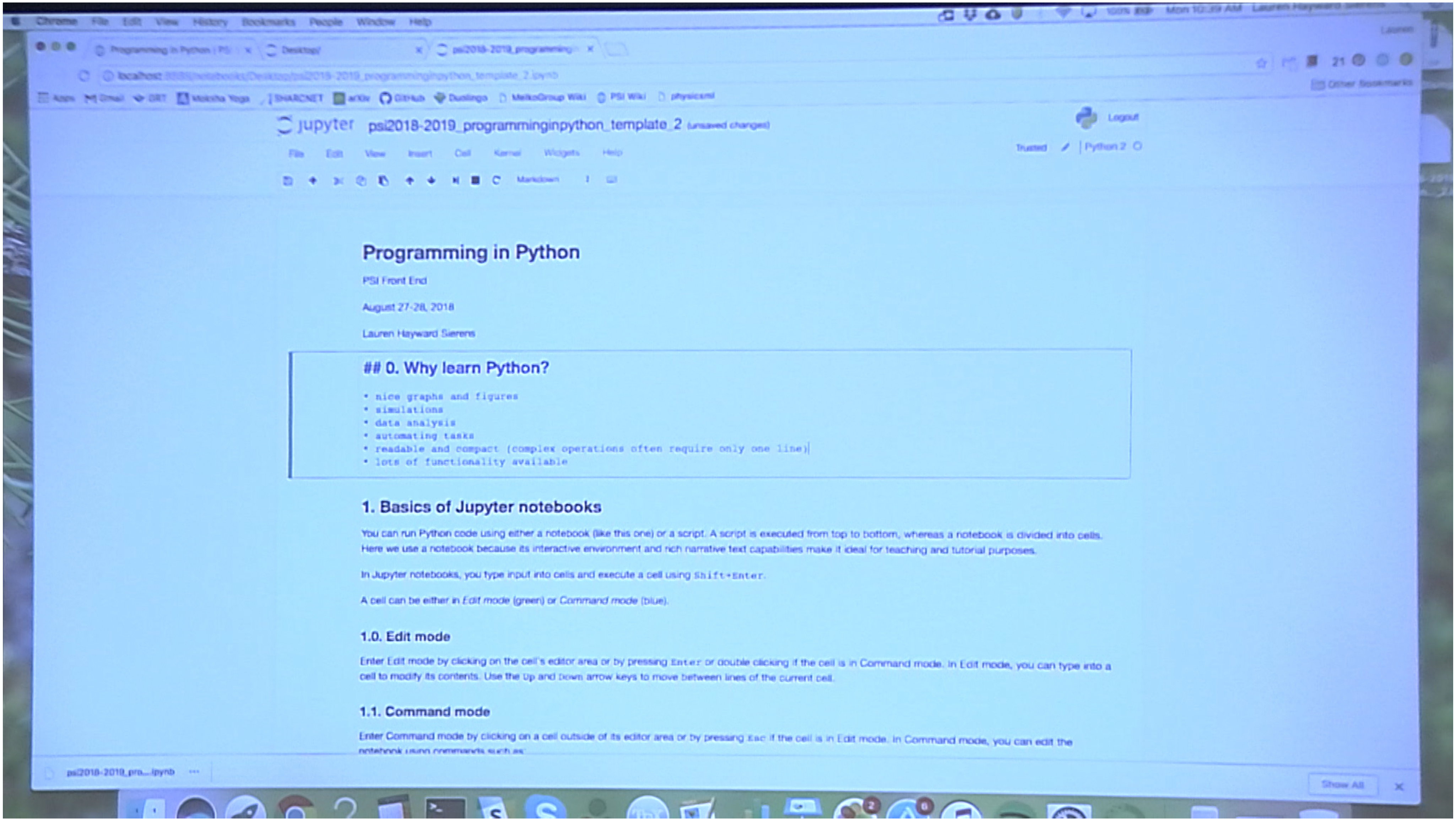
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• readable and compact (complex operations often require only one line)
• lots of functionality available
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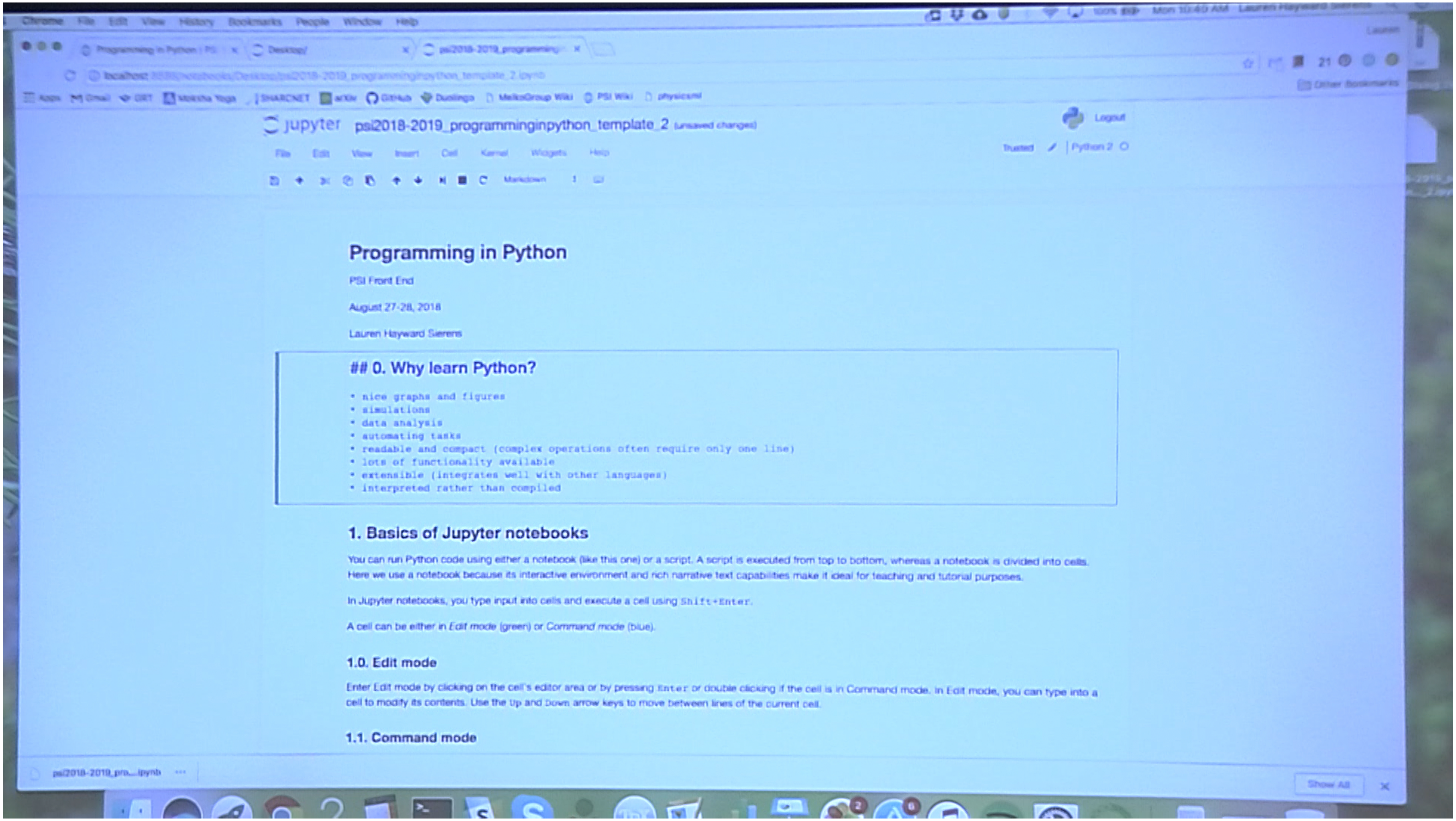
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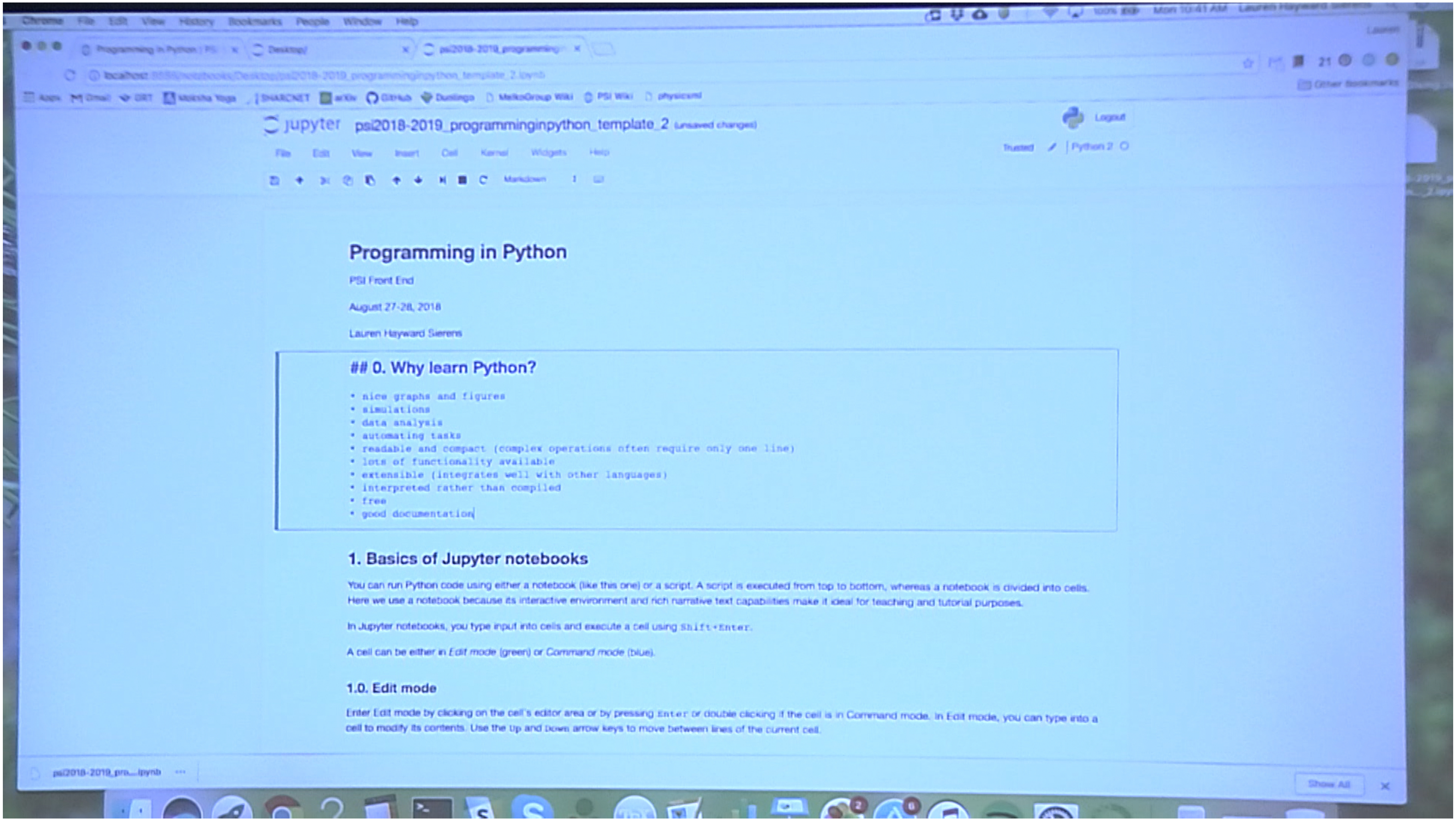
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Programming in Python

PSI Front End

August 27-28, 2018

Lauren Hayward Sierens

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Command	Description
`Y`	make current cell a Code cell for writing and running code
`M`	make current cell a Markdown cell (like this one) for writing stylized text to document your notebook
`Up`	move to the cell above the current cell
`Down`	move to the cell below the current cell
`A`	insert cell above current cell
`B`	insert cell below current cell
`D+D`	delete current cell
`C`	copy current cell

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Up	move to the cell above the current cell
Down	move to the cell below the current cell
A	insert cell above current cell
B	insert cell below current cell
D+D	delete current cell
C	copy current cell
X	cut current cell
V	paste cell below current cell
Shift+V	paste cell above current cell
F	open find and replace for current cell

To see the full list of command-mode commands, open the *command palette* above by clicking on the picture of the keyboard or by pressing `Command+Shift+P` (Mac) or `Ctrl+Shift+P` (Windows).

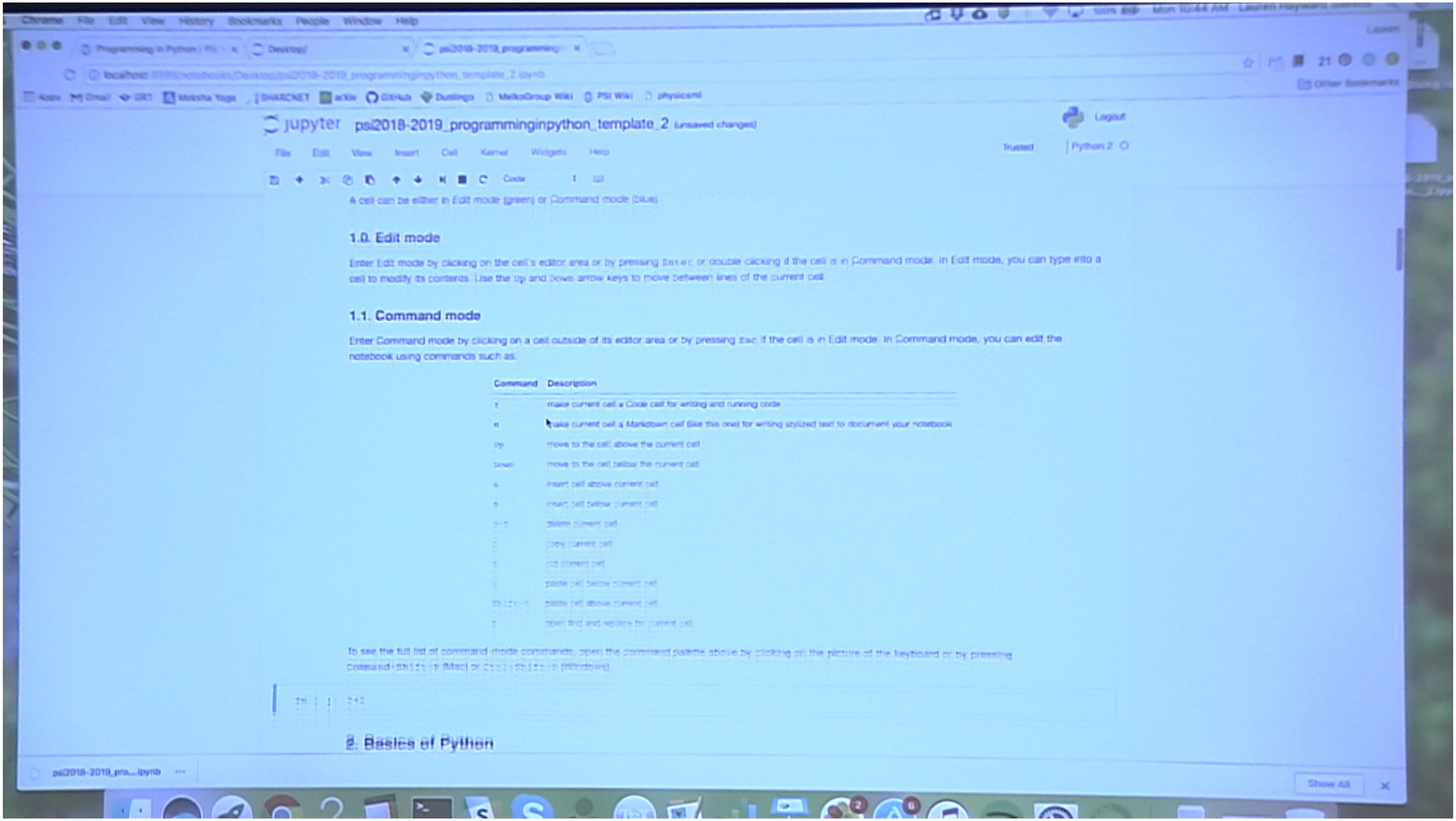
```
In [1]: 2+2
Out[1]: 4
```

2. Basics of Python

2.0. Numbers

We can use Python as a calculator for evaluating numerical expressions. Available arithmetic operators are:

Operator	Description
+	addition
-	subtraction
*	multiplication
/	division or floor division (see below)
//	floor division (also known as integer division)
**	exponent (**Note:** the operator ^ is not an exponential operator!)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In [ ]:
```

2. Basics of Python

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`**`	exponent (**Note:** the operator `^` is not an exponential operator!)
`%`	modulus (returns the remainder upon dividing the left-hand operand by the right-hand operand)

```
In [ ]:
```

Numbers can have different numeric types. Integer numbers (such as `2`, `-9` and `0`) have type `int`. Numbers with a decimal (such as `13.4`, `4.0` and `-12.2`) have type `float`. You can also read about long integers and complex numbers, but we won't use them in this course. Python can determine the number's type without being explicitly told.

Booleans (variables that take one of two possible values) are a subtype of integers.

```
In [ ]:
```

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```
In [2]: (1+3)*(6-4)**3
Out[2]: 32
```

Numbers can have different numeric types. Integer numbers (such as `2`, `-9` and `0`) have type `int`. Numbers with a decimal (such as `13.4`, `4.0` and `-12.2`) have type `float`. You can also read about long integers and complex numbers, but we won't use them in this course. Python can determine the number's type without being explicitly told.

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In [2]: (1+3)*(6-4)**3
Out[2]: 32
```

```
In [3]: 9%5
Out[3]: 4
```

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`%` modulus (returns the remainder upon dividing the left-hand operand by the right-hand operand)

```
In [2]: (1+3)*(6-4)**3
Out[2]: 32

In [3]: 9%5
Out[3]: 4

In [4]: 3/2
Out[4]: 1
```

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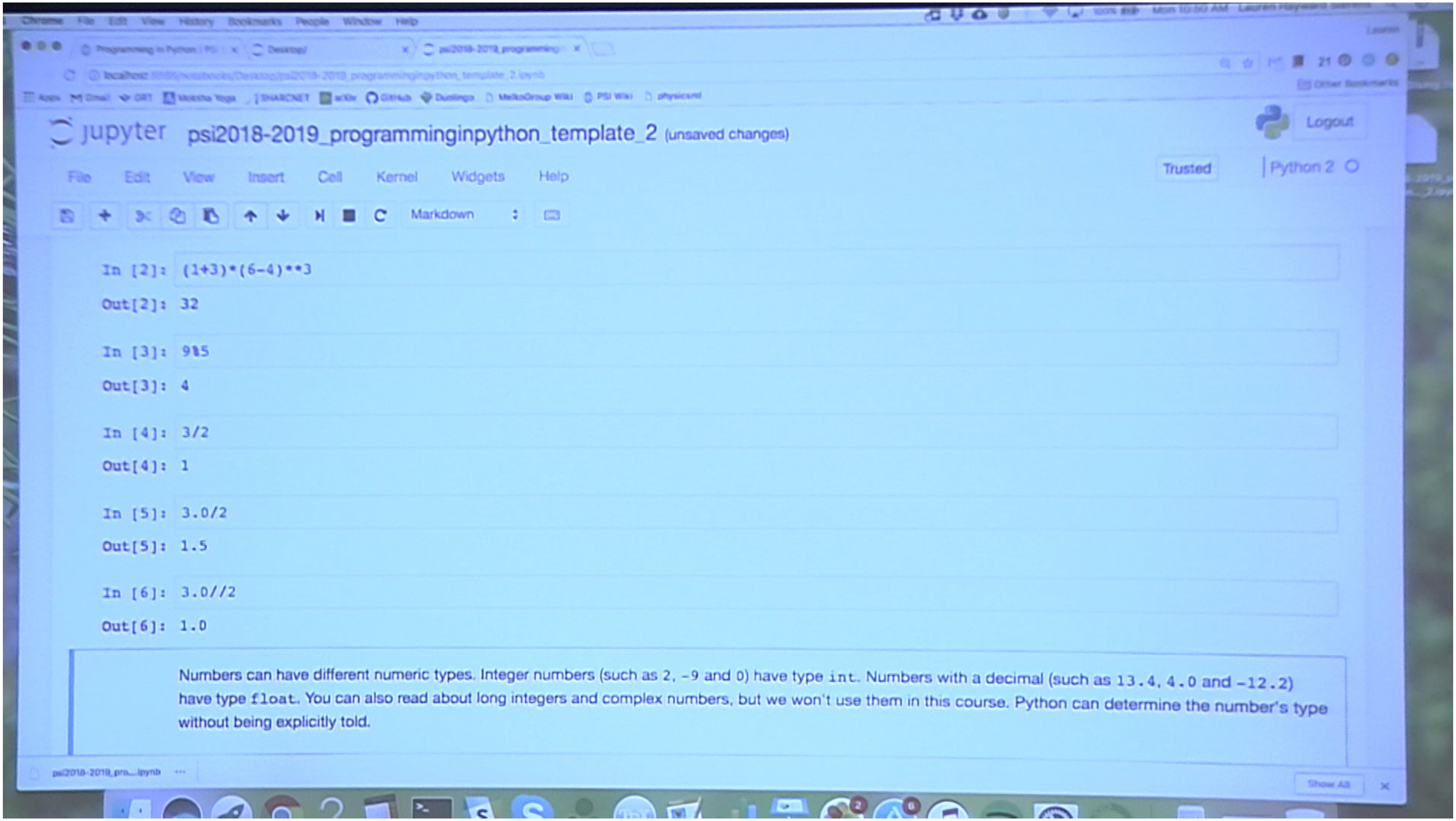
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Python 2
Markdown
In [2]: (1+3)*(6-4)**3
Out[2]: 32
In [3]: 9%5
Out[3]: 4
In [4]: 3/2
Out[4]: 1
In [5]: 3.0/2
Out[5]: 1.5
In [6]: 3.0//2
Out[6]: 1.0
Numbers can have different numeric types. Integer numbers (such as 2, -9 and 0) have type int. Numbers with a decimal (such as 13.4, 4.0 and -12.2) have type float. You can also read about long integers and complex numbers, but we won't use them in this course. Python can determine the number's type without being explicitly told.

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In [ ]:

2.1. Printing

If we enter several numerical expressions on different lines of the same cell, only the last line will be displayed.

In [7]:
```
2+2
4-6
```
Out[7]: -2

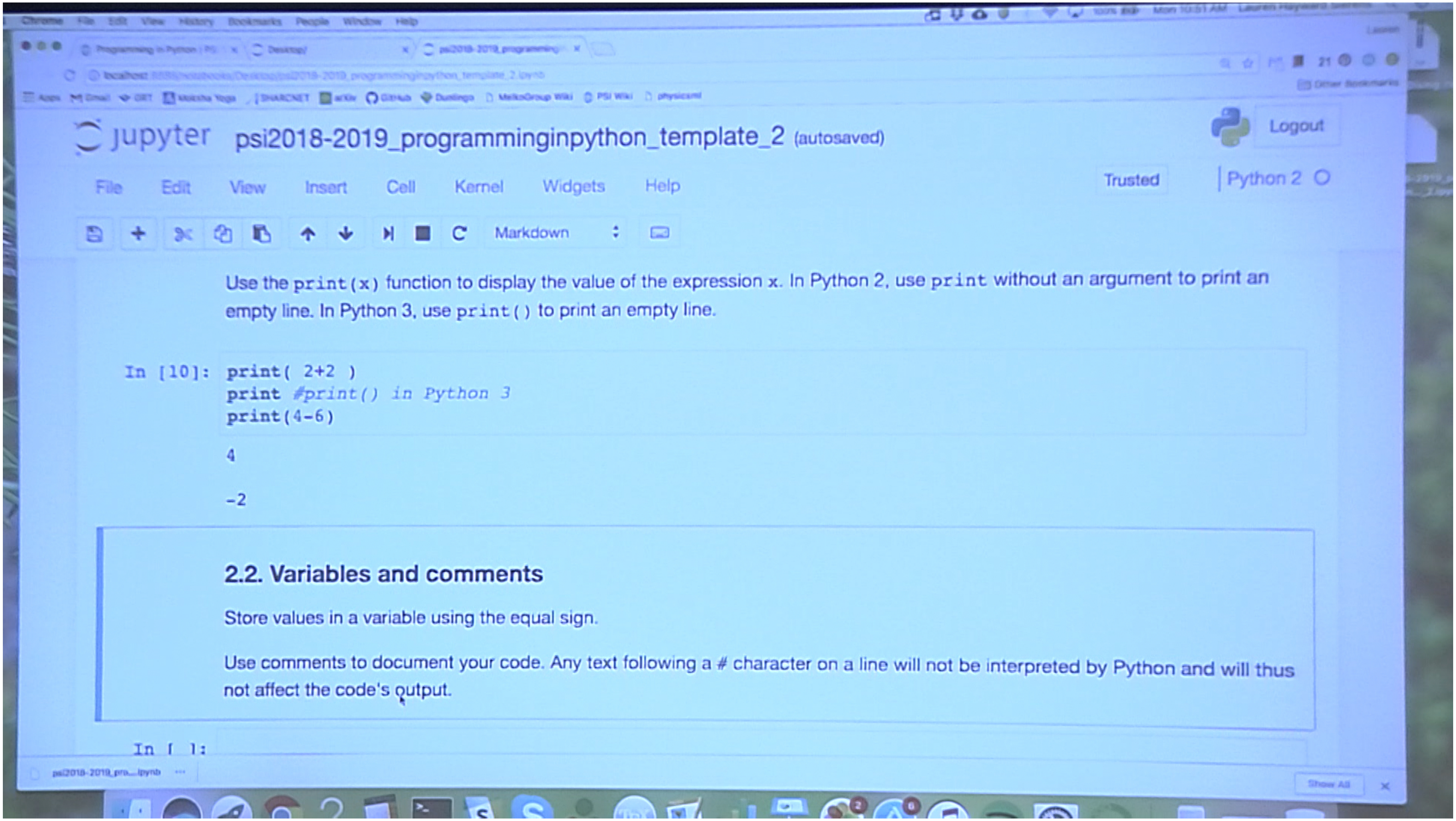
Use the `print(x)` function to display the value of the expression `x`. In Python 2, use `print` without an argument to print an empty line. In Python 3, use `print()` to print an empty line.

In [ ]:

2.2. Variables and comments

Store values in a variable using the equal sign.

Use comments to document your code. Any text following a # character on a line will not be interpreted by Python and will thus not affect the code's output.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Python 2
Markdown
Use the print(x) function to display the value of the expression x. In Python 2, use print without an argument to print an empty line. In Python 3, use print() to print an empty line.
In [10]:
print(2+2)
print #print() in Python 3
print(4-6)
4
-2
2.2. Variables and comments
Store values in a variable using the equal sign.
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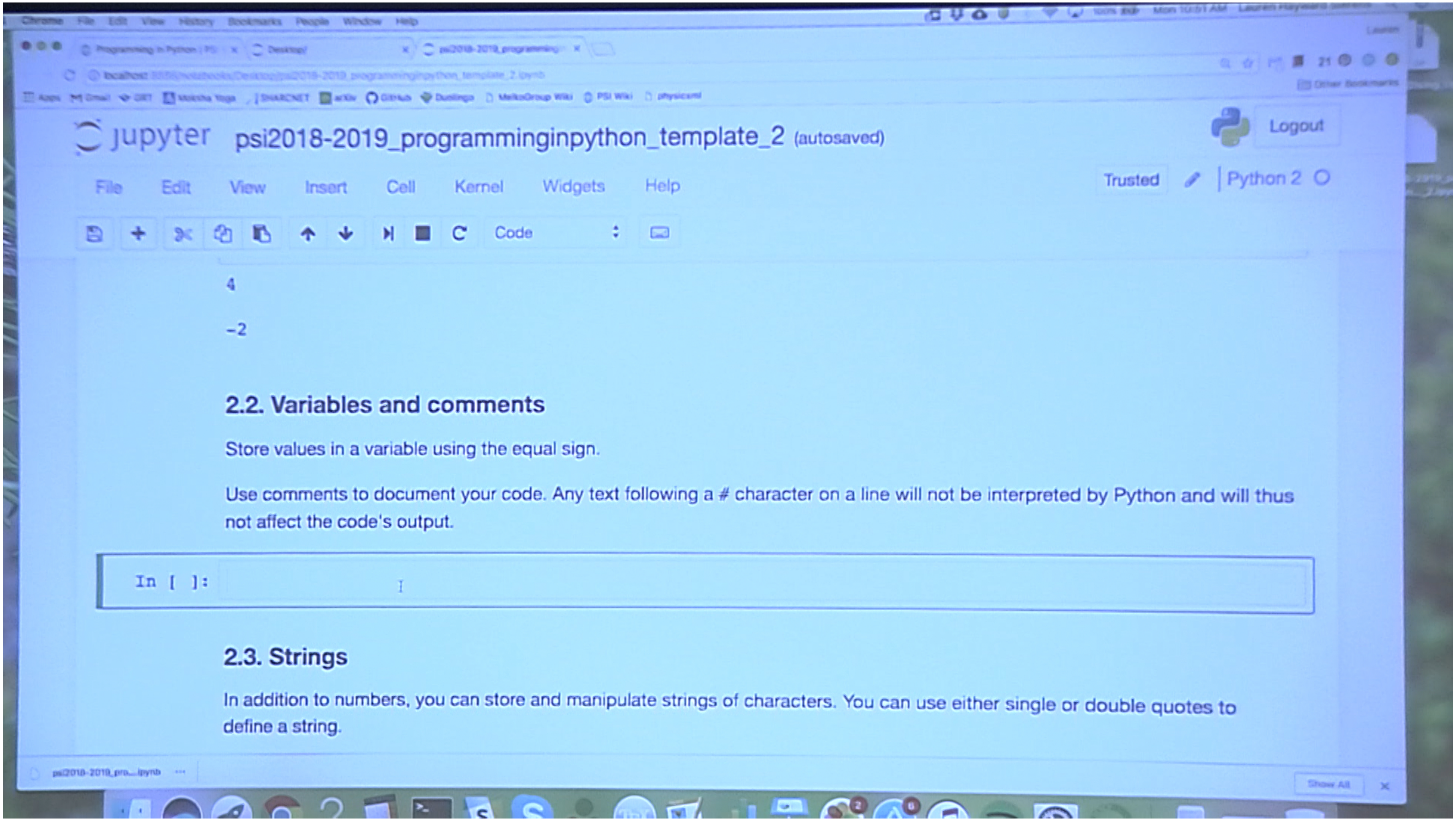
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Store values in a variable using the equal sign.
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2.3. Strings
In addition to numbers, you can store and manipulate strings of characters. You can use either single or double quotes to define a string.

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Code

```
h = 5 #height
print( w*h )
```

50

2.3. Strings

In addition to numbers, you can store and manipulate strings of characters. You can use either single or double quotes to define a string.

In [ ]:

Use the format method to get formatted strings, which are often useful for displaying output in a nice way

In [ ]:

Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when `r=5`, you should print:

```
The area of the circle is 78.53975.
```

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```
h = 5 #height
print( w*h )
```

```
50
```

2.3. Strings

In addition to numbers, you can store and manipulate strings of characters. You can use either single or double quotes to define a string.

In [12]:

```
word1 = "Hello"
word2 = "world"
sentence = word1 + word2 #concatenate using '+'
print(sentence)
```

```
Helloworld
```

Use the format method to get formatted strings, which are often useful for displaying output in a nice way

In [ ]:

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Trusted Python 2

Code

```
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print( w*h )
```

```
50
```

2.3. Strings

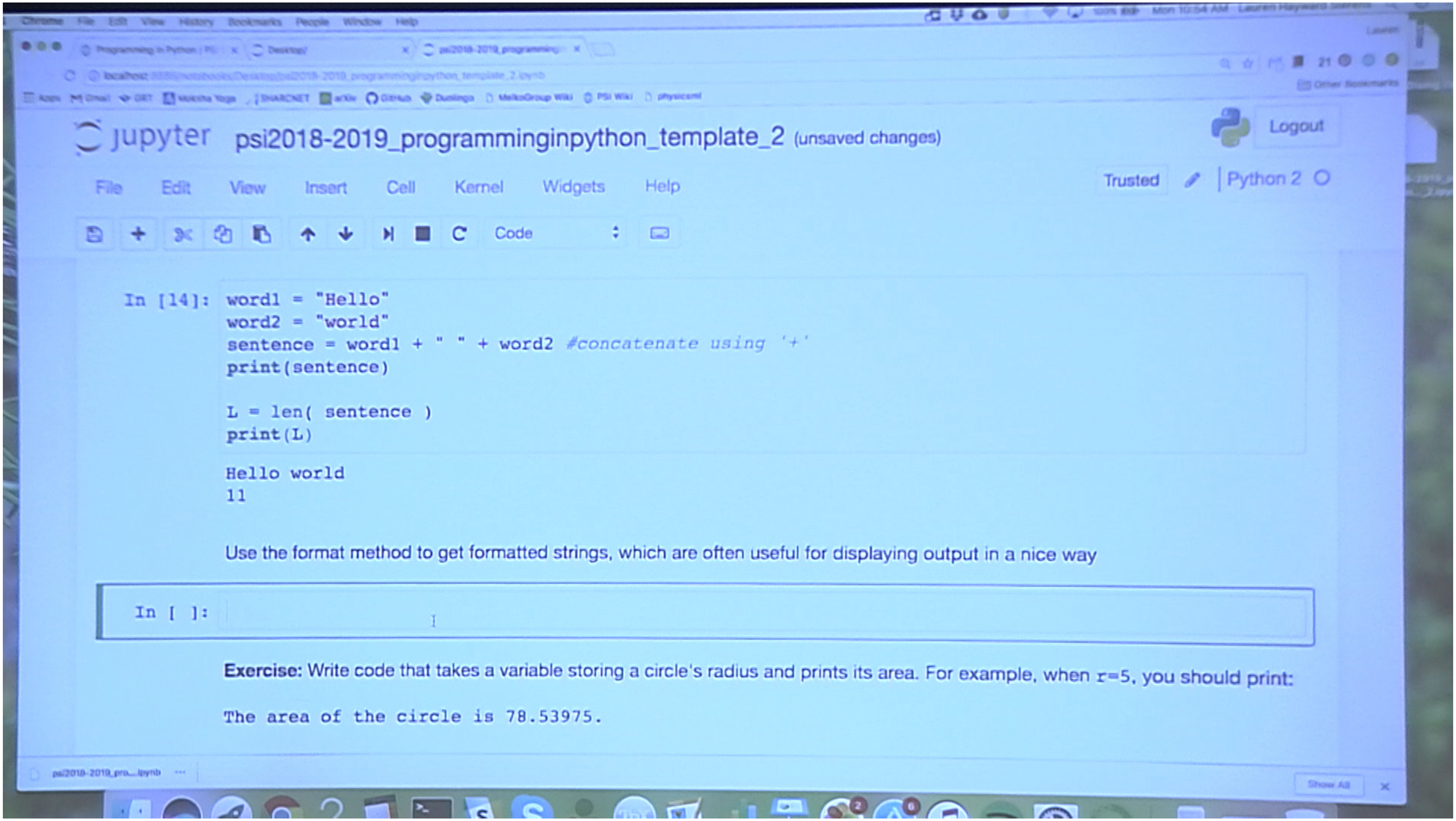
In addition to numbers, you can store and manipulate strings of characters. You can use either single or double quotes to define a string.

In [13]:
```
word1 = "Hello"
word2 = "world"
sentence = word1 + " " + word2 #concatenate using '+'
print(sentence)

L = len()
```

```
Hello world
```

Use the format method to get formatted strings, which are often useful for displaying output in a nice way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Python 2
Code
In [14]:
word1 = "Hello"
word2 = "world"
sentence = word1 + " " + word2 #concatenate using '+'
print(sentence)
L = len(sentence)
print(L)
Hello world
11
Use the format method to get formatted strings, which are often useful for displaying output in a nice way
In [ ]:
Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when r=5, you should print:
The area of the circle is 78.53975.

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In [14]:
```
word1 = "Hello"
word2 = "world"
sentence = word1 + " " + word2 #concatenate using '+'
print(sentence)

L = len( sentence )
print(L)
```

```
Hello world
11
```

Use the format method to get formatted strings, which are often useful for displaying output in a nice way

In [ ]:
```
name = "Lauren"
x = 0
y = 3.2
print( "The coordinates of {} are ({},{})".format(name,x,y) )
```

Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when `r=5`, you should print:

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```
print(sentence)

L = len( sentence )
print(L)
```

```
Hello world
11
```

Use the format method to get formatted strings, which are often useful for displaying output in a nice way

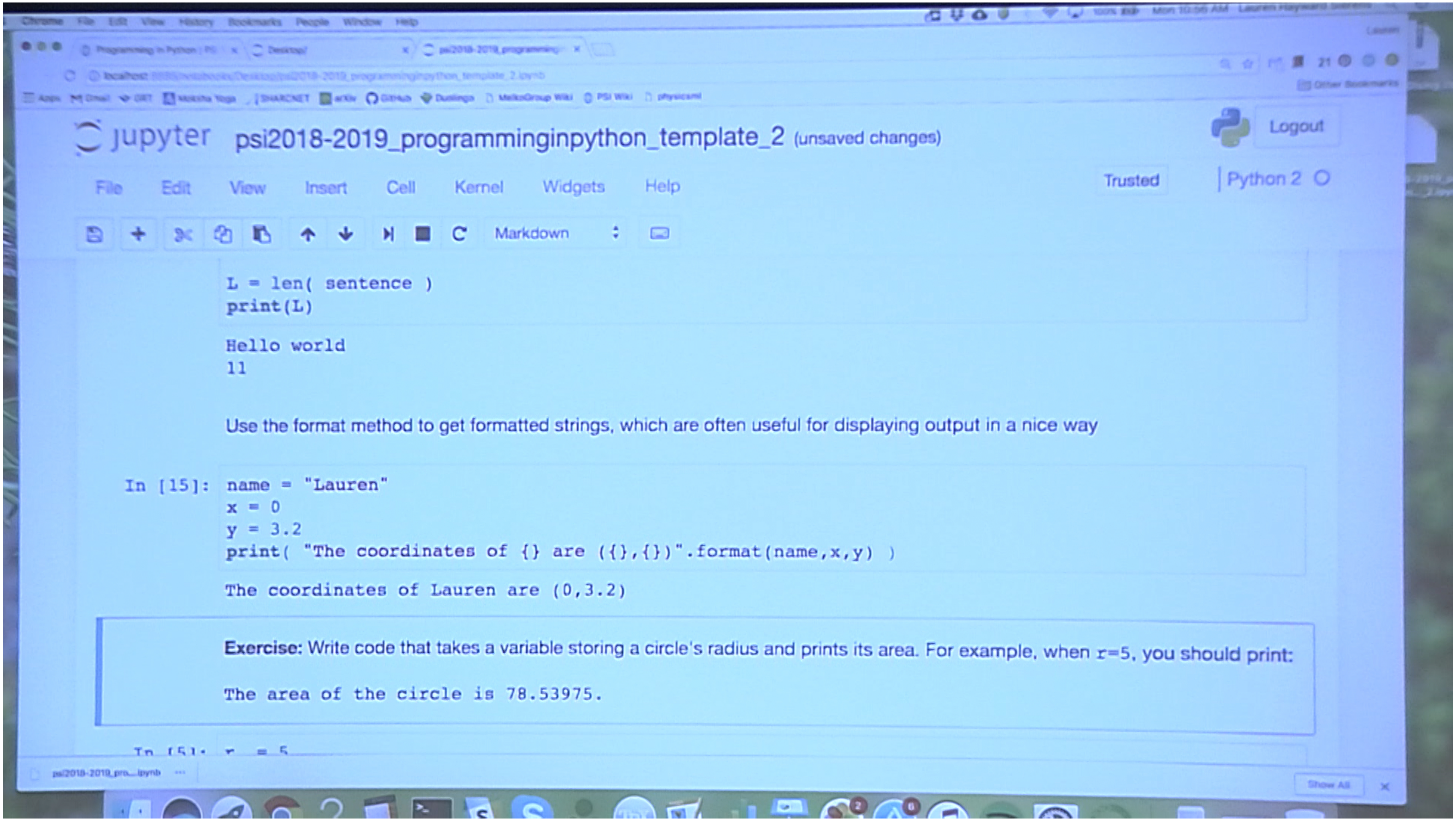
In [15]:

```
name = "Lauren"
x = 0
y = 3.2
print( "The coordinates of {} are ({},{})".format(name,x,y) )
```

```
The coordinates of Lauren are (0,3.2)
```

Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when `r=5`, you should print:

`The area of the circle is 78.53975.`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Python 2
Markdown
L = len(sentence)
print(L)
Hello world
11
Use the format method to get formatted strings, which are often useful for displaying output in a nice way
In [15]:
name = "Lauren"
x = 0
y = 3.2
print("The coordinates of {} are ({},{})".format(name,x,y))
The coordinates of Lauren are (0,3.2)
Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when r=5, you should print:
The area of the circle is 78.53975.

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Use the format method to get formatted strings, which are often useful for displaying output in a nice way

In [15]:
```
name = "Lauren"
x = 0
y = 3.2
print( "The coordinates of {} are ({},{})".format(name,x,y) )
```

```
The coordinates of Lauren are (0,3.2)
```

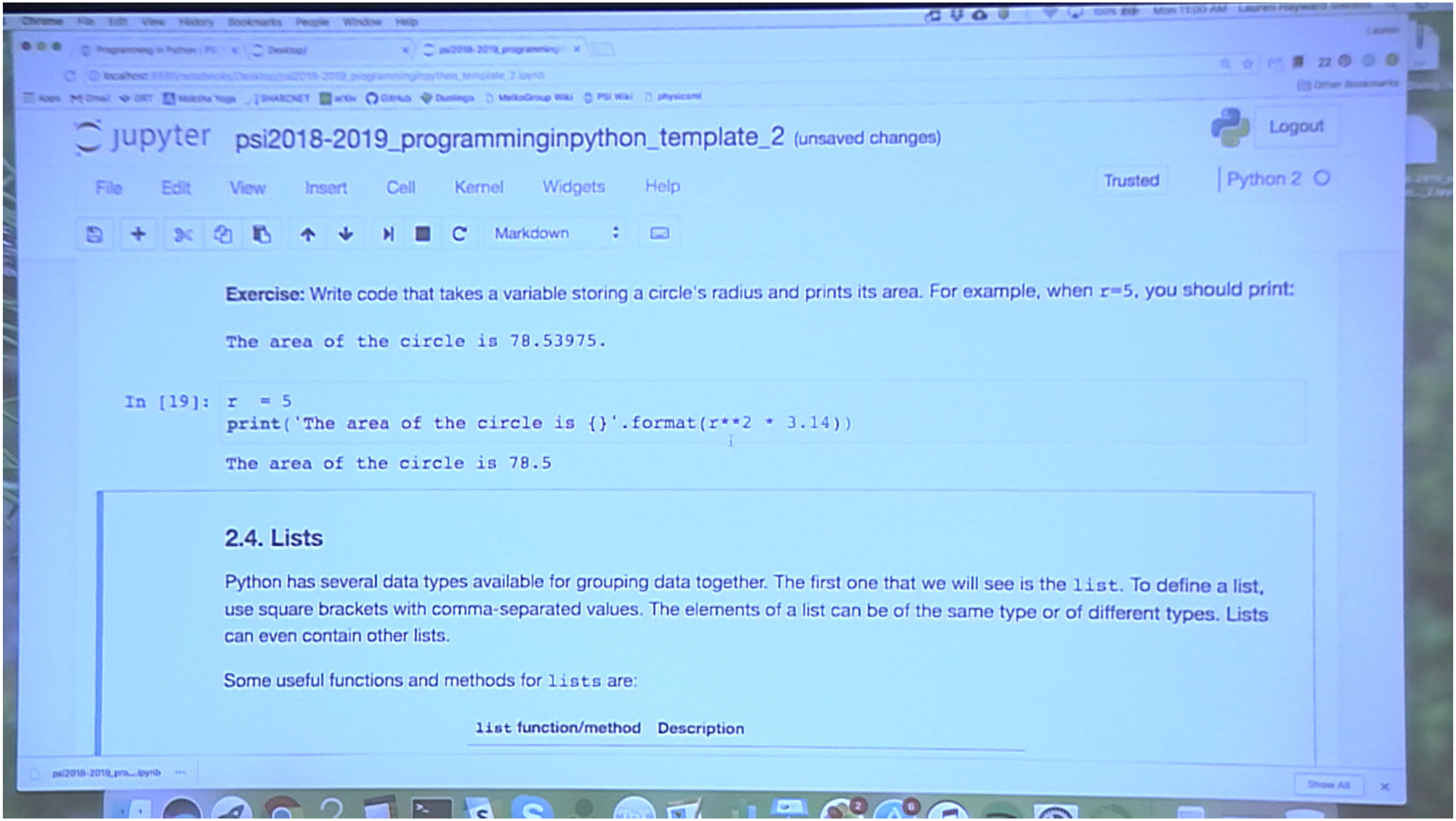
Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when `r=5`, you should print:

```
The area of the circle is 78.53975.
```

In [5]:
```
r  = 5
```

2.4. Lists

Python has several data types available for grouping data together. The first one that we will see is the `list`. To define a list,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Python 2
Markdown
Exercise: Write code that takes a variable storing a circle's radius and prints its area. For example, when r=5, you should print:
The area of the circle is 78.53975.
In [19]: r = 5
print('The area of the circle is {}'.format(r**2 * 3.14))
The area of the circle is 78.5
2.4. Lists
Python has several data types available for grouping data together. The first one that we will see is the list. To define a list, use square brackets with comma-separated values. The elements of a list can be of the same type or of different types. Lists can even contain other lists.
Some useful functions and methods for lists are:
list function/method Description

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Python has several data types available for grouping data together. The first one that we will see is the `list`. To define a list, use square brackets with comma-separated values. The elements of a list can be of the same type or of different types. Lists can even contain other lists.

Some useful functions and methods for `lists` are:

`list` function/method	Description
`+`	concatenates `lists`
`len(list)`	outputs the `list` length
`min(list)`	outputs the smallest item in `list`
`max(list)`	outputs the largest item in `list`
`list.append(x)`	adds a new item `x` to the end of `list`
`list.sort()`	sorts the elements of `list`
`sorted(list)`	return a new sorted list with the elements of `list`

In [ ]:

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```
print( A )
print( B )
```

```
[4, 12, -2]
['a', 0, 4.2, [4, 5]]
```

In [22]:
```
A+B
```

Out[22]:
```
[4, 12, -2, 'a', 0, 4.2, [4, 5]]
```

In [23]:
```
max(A)
```

Out[23]:
```
12
```

2.5. Indexing and slicing

Both strings and lists can be indexed. The first element always has index 0.

You can also use negative indices to index elements counting from end.

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In [22]:
```
A+B
```
Out[22]:
```
[4, 12, -2, 'a', 0, 4.2, [4, 5]]
```

In [23]:
```
max(A)
```
Out[23]:
```
12
```

In [26]:
```
A.append(3)
print( A )

A.append(B)
print( A )
```
```
[4, 12, -2, 3, 3, ['a', 0, 4.2, [4, 5]], 3]
[4, 12, -2, 3, 3, ['a', 0, 4.2, [4, 5]], 3, ['a', 0, 4.2, [4, 5]]]
```

2.5. Indexing and slicing

Both strings and lists can be indexed. The first element always has index 0.

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In [30]:
```
A.append(3)
print( A )

A.append(B)
print( A )
```

```
[4, 12, -2, 3]
[4, 12, -2, 3, ['a', 0, 4.2, [4, 5]]]
```

In [32]:
```
C = [6,-2.45, 12.3, -203]
print( C )
D = sorted(C)
print( D )
```

```
[6, -2.45, 12.3, -203]
[-203, -2.45, 6, 12.3]
```

2.5. Indexing and slicing

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```
[6, -2.45, 12.3, -203]

[6, -2.45, 12.3, -203]
[-203, -2.45, 6, 12.3]

[-203, -2.45, 6, 12.3]
```

2.5. Indexing and slicing

Both strings and lists can be indexed. The first element always has index 0.

You can also use negative indices to index elements counting from end.

```
In [6]: B = ["a", 0, 4.2, [4,5] ]
```

Use *slicing* to get a subset of your list or string.

```
In [7]: s = "abcdef"
```

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```
[6, -2.45, 12.3, -203]
[-203, -2.45, 6, 12.3]

[-203, -2.45, 6, 12.3]
```

2.5. Indexing and slicing

Both strings and lists can be indexed. The first element always has index 0.

You can also use negative indices to index elements counting from end.

```
In [38]: B = ["a", 0, 4.2, [4,5] ]

         print( B[0] ) #print the first character
         print( B[-1] ) #print the last character
         print( B[-4] ) #print the fourthnlast character

a
[4, 5]
```

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2.5. Indexing and slicing

Both strings and lists can be indexed. The first element always has index 0.

You can also use negative indices to index elements counting from end.

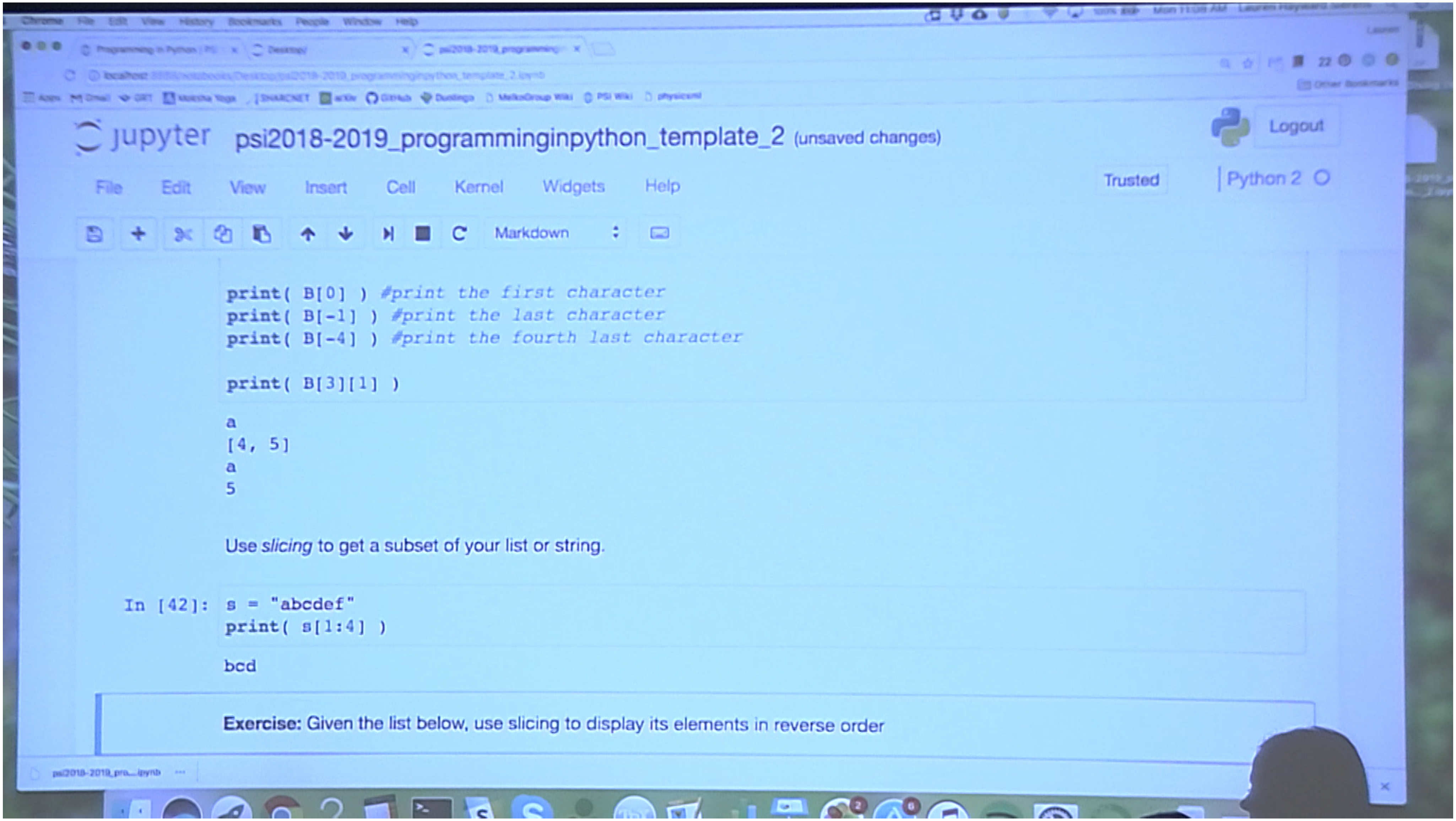
In [41]:
```
B = ["a", 0, 4.2, [4,5] ]

print( B[0] ) #print the first character
print( B[-1] ) #print the last character
print( B[-4] ) #print the fourth last character

print( B[3][1] )
```

```
a
[4, 5]
a
5
```

Use *slicing* to get a subset of your list or string.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Python 2
Markdown
print(B[0]) #print the first character
print(B[-1]) #print the last character
print(B[-4]) #print the fourth last character
print(B[3][1])
a
[4, 5]
a
5
Use slicing to get a subset of your list or string.
In [42]: s = "abcdef"
print(s[1:4])
bcd
Exercise: Given the list below, use slicing to display its elements in reverse order

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```
print( B[-4] ) #print the fourth last character

print( B[3][1] )
```

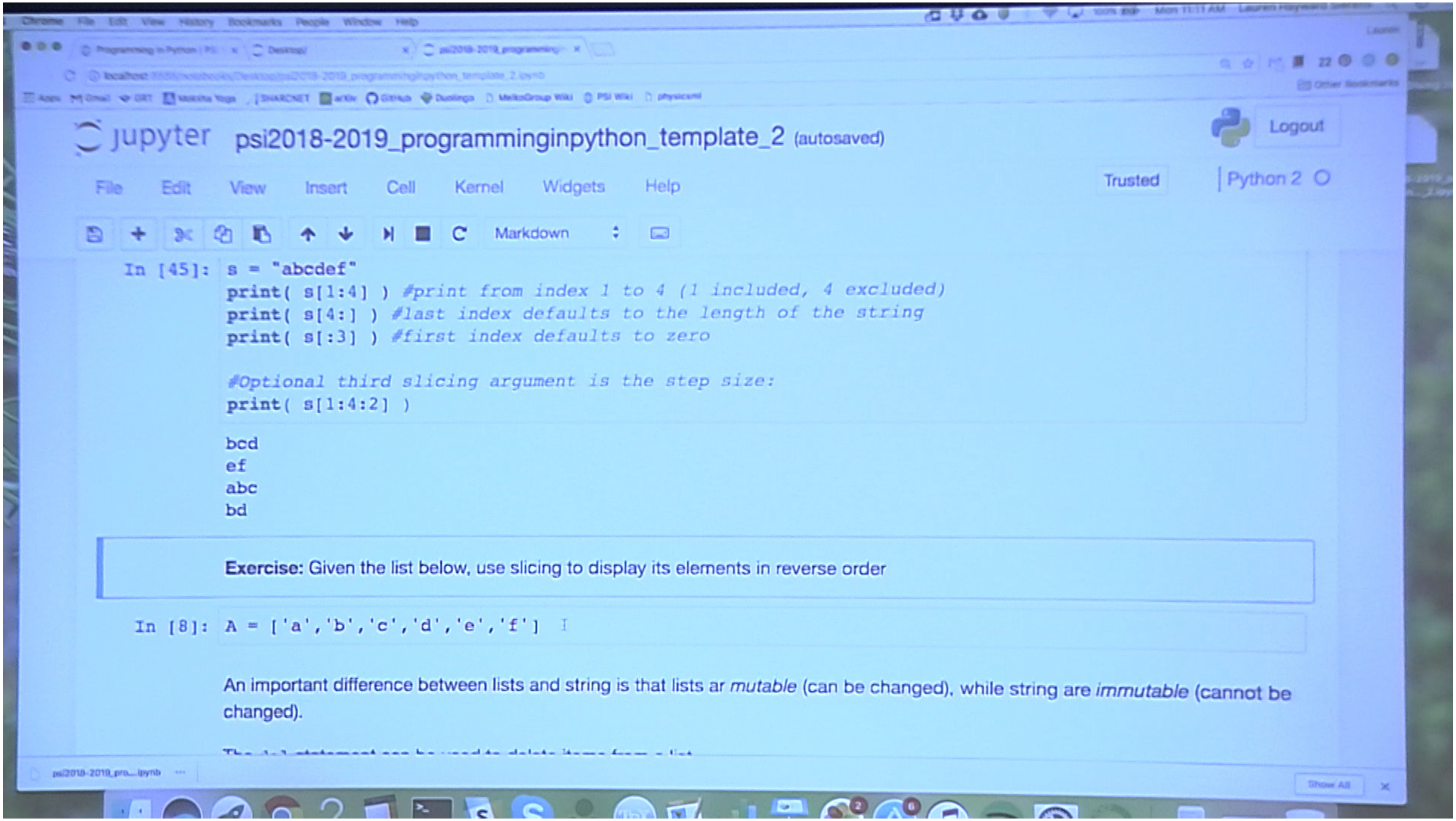
```
a
[4, 5]
a
5
```

Use *slicing* to get a subset of your list or string.

In [44]:
```
s = "abcdef"
print( s[1:4] ) #print from index 1 to 4 (1 included, 4 excluded)
print( s[4:] ) #last index defaults to the length of the string
print( s[:3] ) #first index defaults to zero
```

```
bcd
ef
abc
```

Exercise: Given the list below, use slicing to display its elements in reverse order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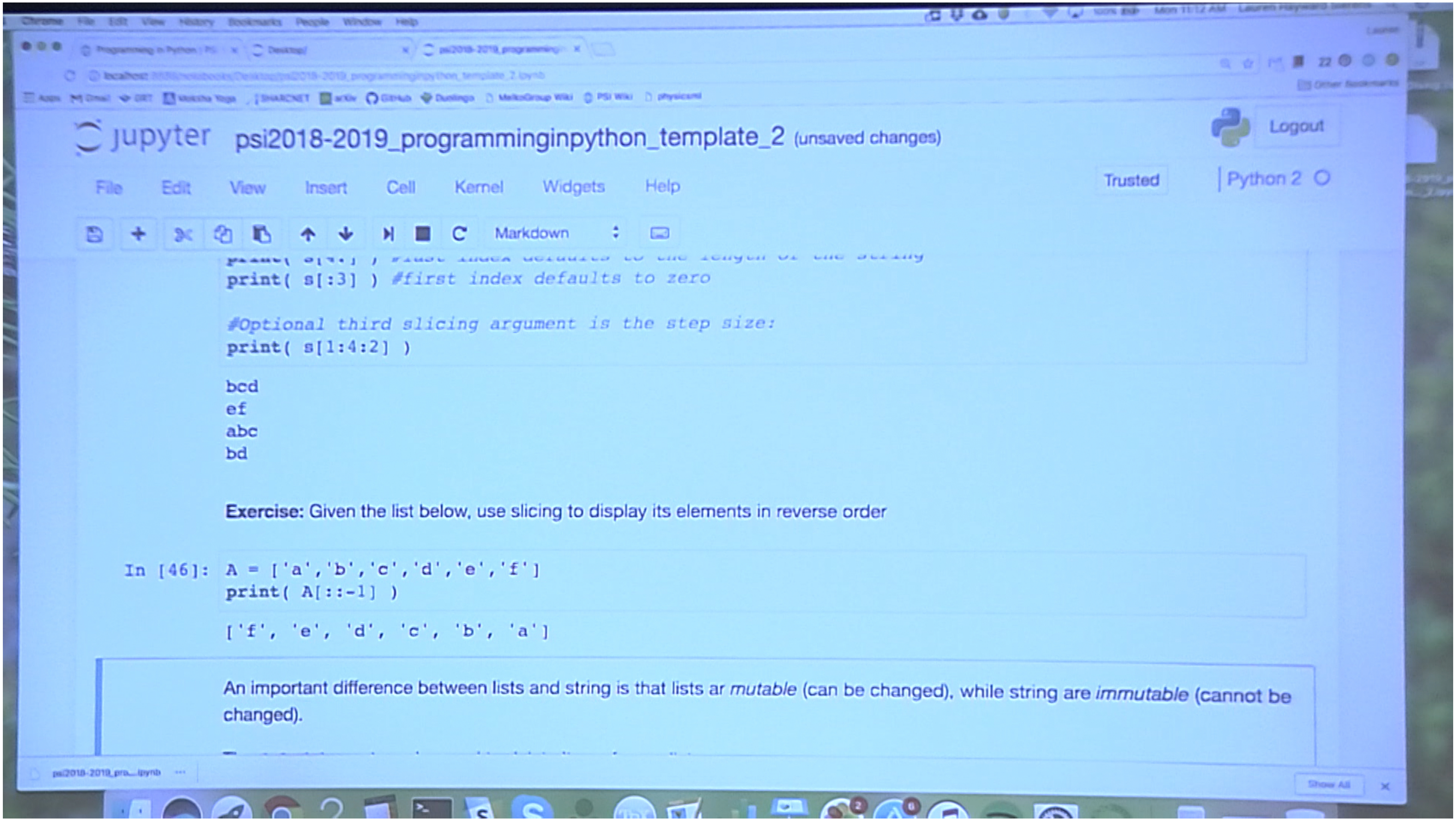
Python 2
Markdown
In [45]: s = "abcdef"
print(s[1:4]) #print from index 1 to 4 (1 included, 4 excluded)
print(s[4:]) #last index defaults to the length of the string
print(s[:3]) #first index defaults to zero
#Optional third slicing argument is the step size:
print(s[1:4:2])
bcd
ef
abc
bd
Exercise: Given the list below, use slicing to display its elements in reverse order
In [8]: A = ['a','b','c','d','e','f']
An important difference between lists and string is that lists ar mutable (can be changed), while string are immutable (cannot be changed).



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Python 2
Markdown
print(s[:3]) #first index defaults to zero
#Optional third slicing argument is the step size:
print(s[1:4:2])
bcd
ef
abc
bd
Exercise: Given the list below, use slicing to display its elements in reverse order
In [46]: A = ['a','b','c','d','e','f']
print(A[::-1])
['f', 'e', 'd', 'c', 'b', 'a']
An important difference between lists and string is that lists ar mutable (can be changed), while string are immutable (cannot be changed).

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```
print( A[::-1] )
```

```
['f', 'e', 'd', 'c', 'b', 'a']
```

An important difference between lists and string is that lists ar *mutable* (can be changed), while string are *immutable* (cannot be changed).

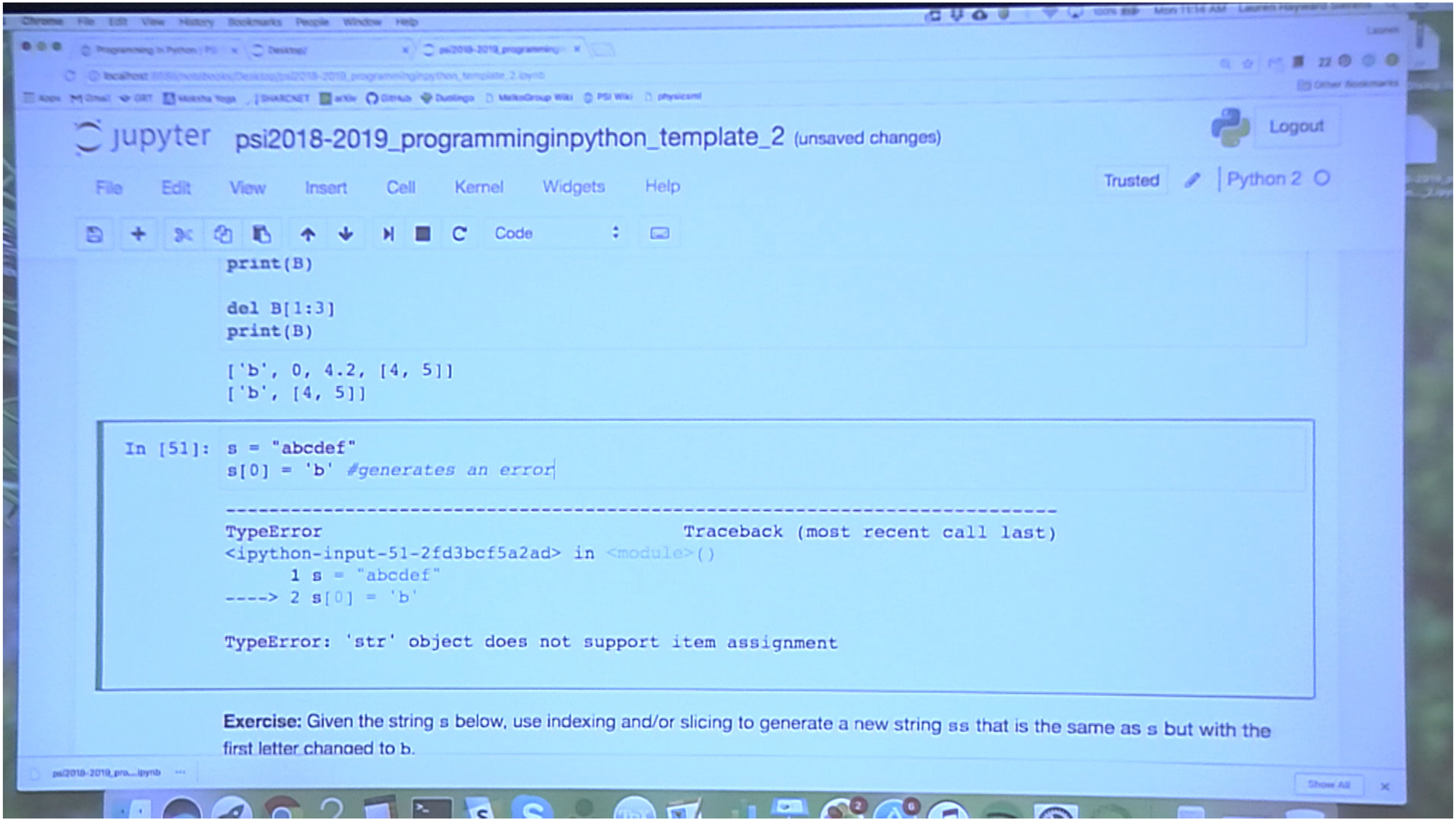
The `del` statement can be used to delete items from a list.

```
In [9]: B = ["a", 0, 4.2, [4,5] ]
```

```
In [10]: s = "abcdef"
```

Exercise: Given the string `s` below, use indexing and/or slicing to generate a new string `ss` that is the same as `s` but with the first letter changed to `b`.

```
In [11]: s = "abcdef"
```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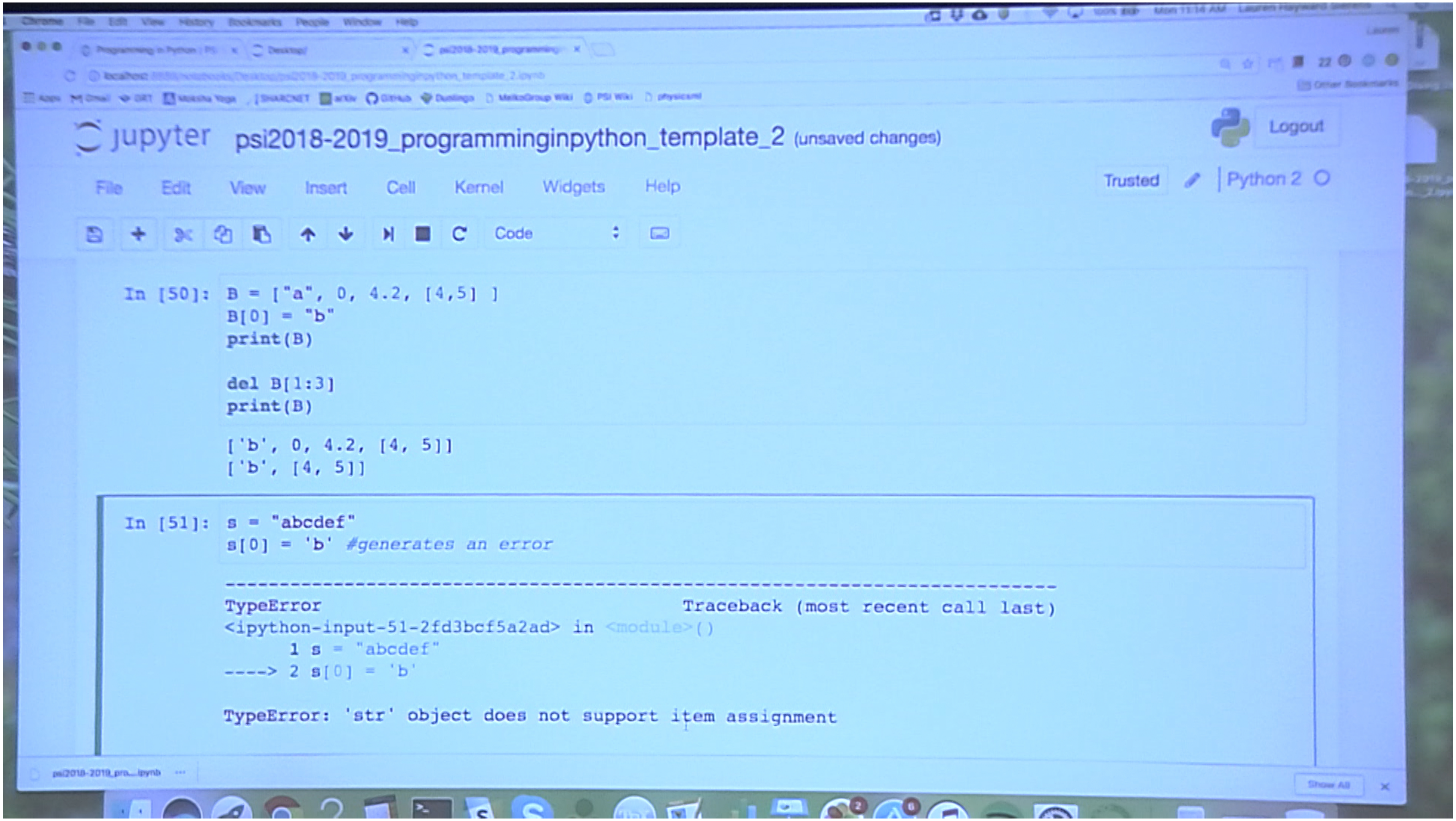
Python 2
Code
print(B)
del B[1:3]
print(B)
['b', 0, 4.2, [4, 5]]
['b', [4, 5]]
In [51]: s = "abcdef"
s[0] = 'b' #generates an error
TypeError Traceback (most recent call last)
<ipython-input-51-2fd3bcf5a2ad> in <module>()
1 s = "abcdef"
----> 2 s[0] = 'b'
TypeError: 'str' object does not support item assignment
Exercise: Given the string s below, use indexing and/or slicing to generate a new string ss that is the same as s but with the
first letter changed to b.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Trusted
Python 2
Code
In [50]: B = ["a", 0, 4.2, [4,5]]
B[0] = "b"
print(B)
del B[1:3]
print(B)
['b', 0, 4.2, [4, 5]]
['b', [4, 5]]
In [51]: s = "abcdef"
s[0] = 'b' #generates an error

TypeError Traceback (most recent call last)
<ipython-input-51-2fd3bcf5a2ad> in <module>()
1 s = "abcdef"
----> 2 s[0] = 'b'
TypeError: 'str' object does not support item assignment

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first letter changed to `b`.

```
In [11]: s = "abcdef"
```

2.6. Dictionaries

Dictionaries are another mutable data type in Python. Unlike a `list`, which is indexed by a range of numbers, a `dict` is indexed by keys that you define. Each key can be a string, a number, or any other immutable type. You can think of a dictionary as a mapping.

```
In [ ]: D
```

You can read about other available data structures such as tuples and sets, but we won't use them in this course.

2.7. Other useful Python tools

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first letter changed to b.

```
In [11]: s = "abcdef"
```

2.6. Dictionaries

Dictionaries are another mutable data type in Python. Unlike a `list`, which is indexed by a range of numbers, a `dict` is indexed by keys that you define. Each key can be a string, a number, or any other immutable type. You can think of a dictionary as a mapping.

```
In [53]: D = { "abc":"a", "a":0, 4:2 }
         print(D)

{'a': 0, 'abc': 'a', 4: 2}
```

You can read about other available data structures such as tuples and sets, but we won't use them in this course.

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Python 2

Markdown

first letter changed to b.

In [11]:
```
s = "abcdef"
```

2.6. Dictionaries

Dictionaries are another mutable data type in Python. Unlike a `list`, which is indexed by a range of numbers, a `dict` is indexed by keys that you define. Each key can be a string, a number, or any other immutable type. You can think of a dictionary as a mapping.

In [55]:
```
D = { "abc":"a", "a":0, 4:2 }
print(D)
print( D["a"] )
print( D.keys() )
```

```
{'a': 0, 'abc': 'a', 4: 2}
0
['a', 'abc', 4]
```

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Code

first letter changed to b.

```
In [11]: s = "abcdef"
```

2.6. Dictionaries

Dictionaries are another mutable data type in Python. Unlike a `list`, which is indexed by a range of numbers, a `dict` is indexed by keys that you define. Each key can be a string, a number, or any other immutable type. You can think of a dictionary as a mapping.

```
In [55]: D = { "abc":"a", "a":0, 4:2 }
         print(D)
         print( D["a"] )
         print( D.keys() )

         D["new key"]

{'a': 0, 'abc': 'a', 4: 2}
0
```

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indexed by keys that you define. Each key can be a string, a number, or any other immutable type. You can think of a dictionary as a mapping.

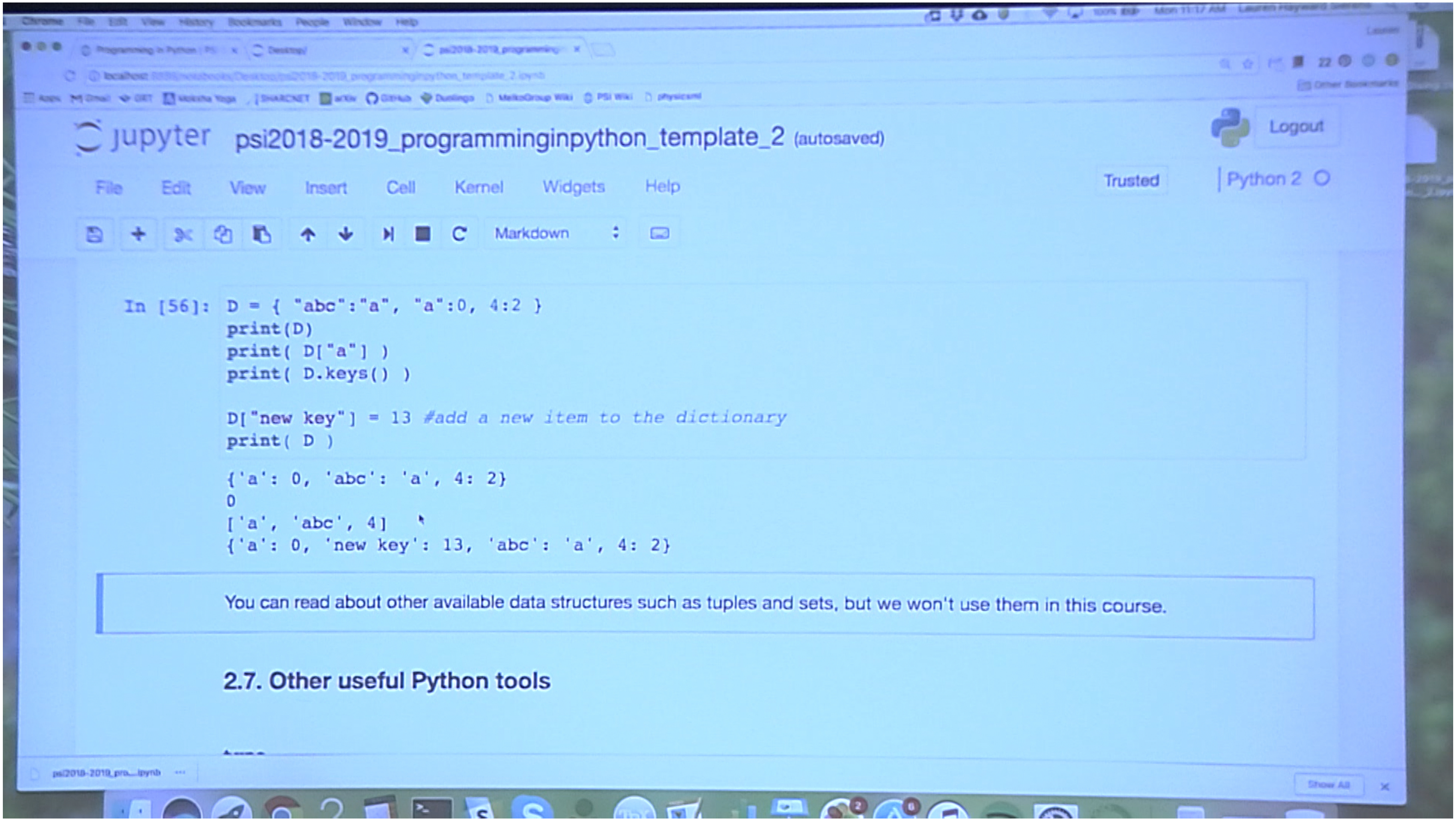
In [56]:
```
D = { "abc":"a", "a":0, 4:2 }
print(D)
print( D["a"] )
print( D.keys() )

D["new key"] = 13 #add a new item to the dictionary
print( D )
```

```
{'a': 0, 'abc': 'a', 4: 2}
0
['a', 'abc', 4]
{'a': 0, 'new key': 13, 'abc': 'a', 4: 2}
```

You can read about other available data structures such as tuples and sets, but we won't use them in this course.

2.7. Other useful Python tools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Python 2
Markdown
In [56]: D = { "abc":"a", "a":0, 4:2 }
print(D)
print(D["a"])
print(D.keys())
D["new key"] = 13 #add a new item to the dictionary
print(D)
{'a': 0, 'abc': 'a', 4: 2}
0
['a', 'abc', 4]
{'a': 0, 'new key': 13, 'abc': 'a', 4: 2}
You can read about other available data structures such as tuples and sets, but we won't use them in this course.
2.7. Other useful Python tools

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You can read about other available data structures such as tuples and sets, but we won't use them in this course.

2.7. Other useful Python tools

`type`

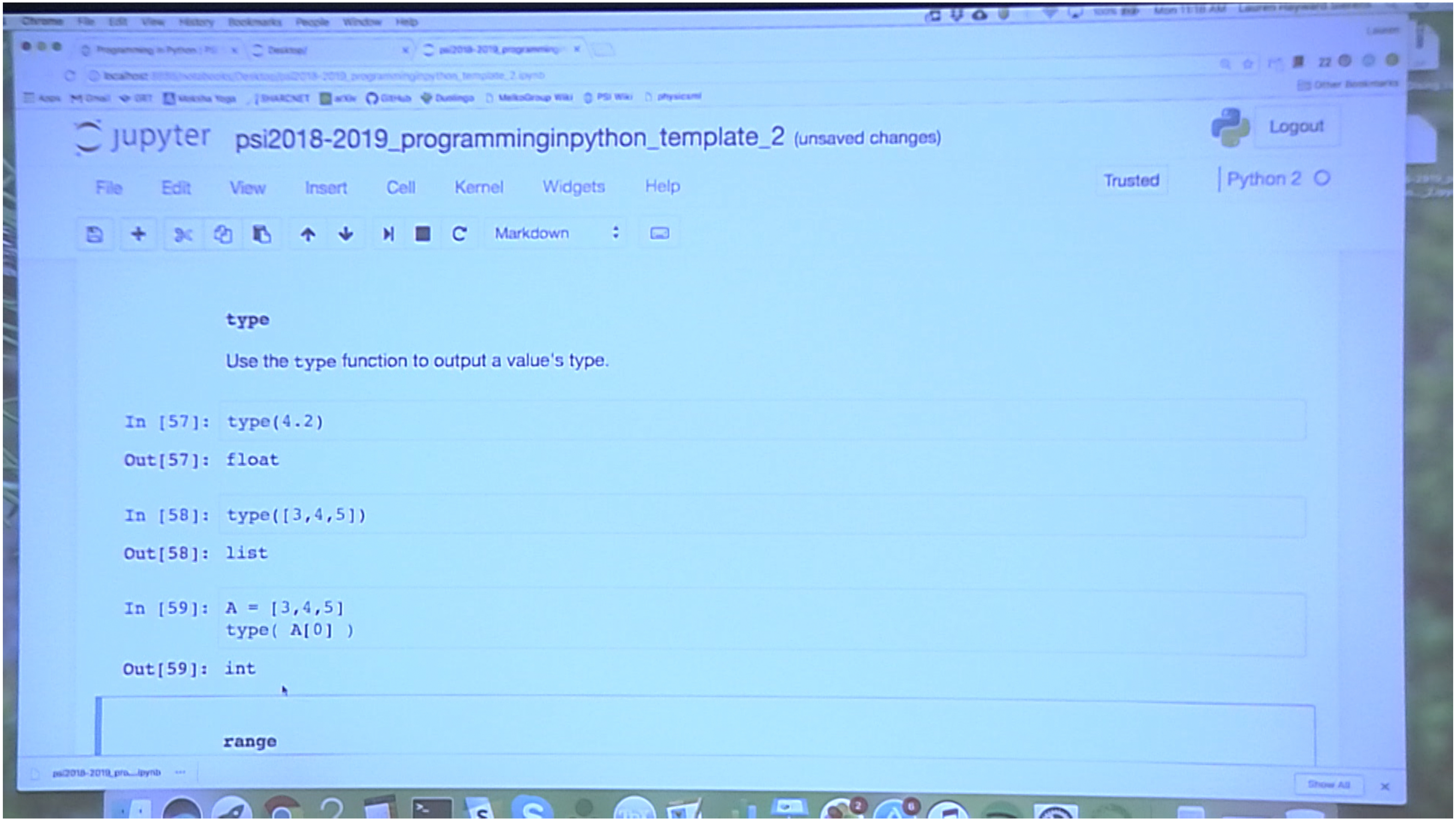
Use the `type` function to output a value's type.

```
In [ ]: 
```

`range`

The `range` function can be used to generate lists that contain sequences of numbers.

```
In [12]: #With one argument, range(stop) gives a sequence of integers from 0 to stop-1:
```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Python 2
Markdown
type
Use the type function to output a value's type.
In [57]: type(4.2)
Out[57]: float
In [58]: type([3,4,5])
Out[58]: list
In [59]: A = [3,4,5]
type(A[0])
Out[59]: int
range

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```
In [58]: type([3,4,5])

Out[58]: list

In [59]: A = [3,4,5]
         type( A[0] )

Out[59]: int
```

range

The `range` function can be used to generate lists that contain sequences of numbers.

```
In [12]: #With one argument, range(stop) gives a sequence of integers from 0 to stop-1:
         print( range(12) )

         #With two arguments, range(start,stop) gives a sequence of integers from start to stop-1

         #An optional third argument is the step size:
```

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Markdown

```
#An optional third argument is the step size:
print( range(2, 12, 5) )
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 7]
```

`import` and `time`

Often, we will want to use a package or module that is not included by default. In this case we can use the `import` command to import packages, functions, modules or submodules.

One such useful module is called `time` and can be used for timing how long code takes to run.

In [13]:
```
import time #import the time module
```

3. Control structures

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```
#An optional third argument is the step size:
print( range(2, 12, 5) )
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 7]
```

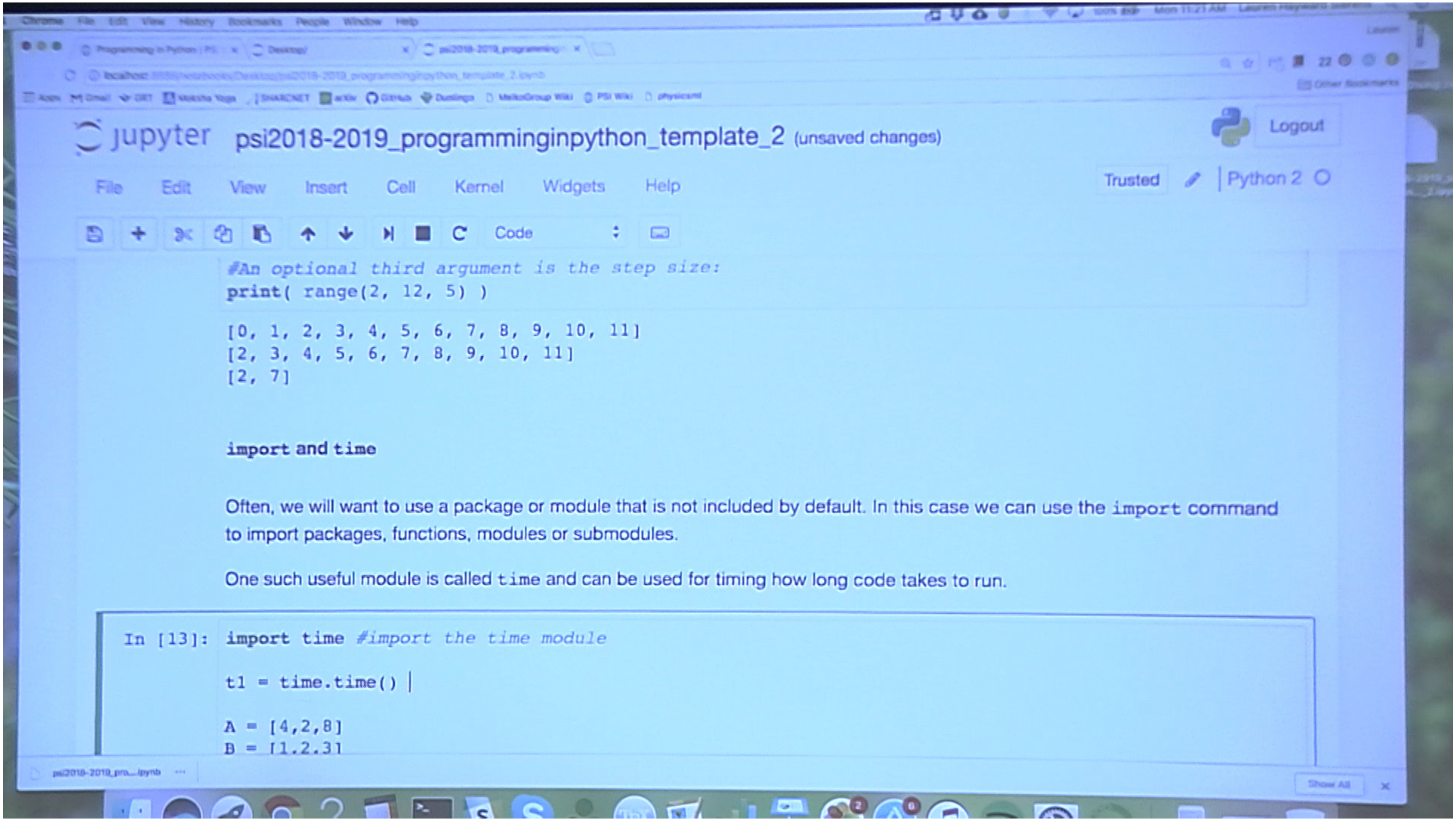
`import` and `time`

Often, we will want to use a package or module that is not included by default. In this case we can use the `import` command to import packages, functions, modules or submodules.

One such useful module is called `time` and can be used for timing how long code takes to run.

In [13]:
```
import time #import the time module

A = [4,2,8]
B = [1,2,3]
C = A+B
```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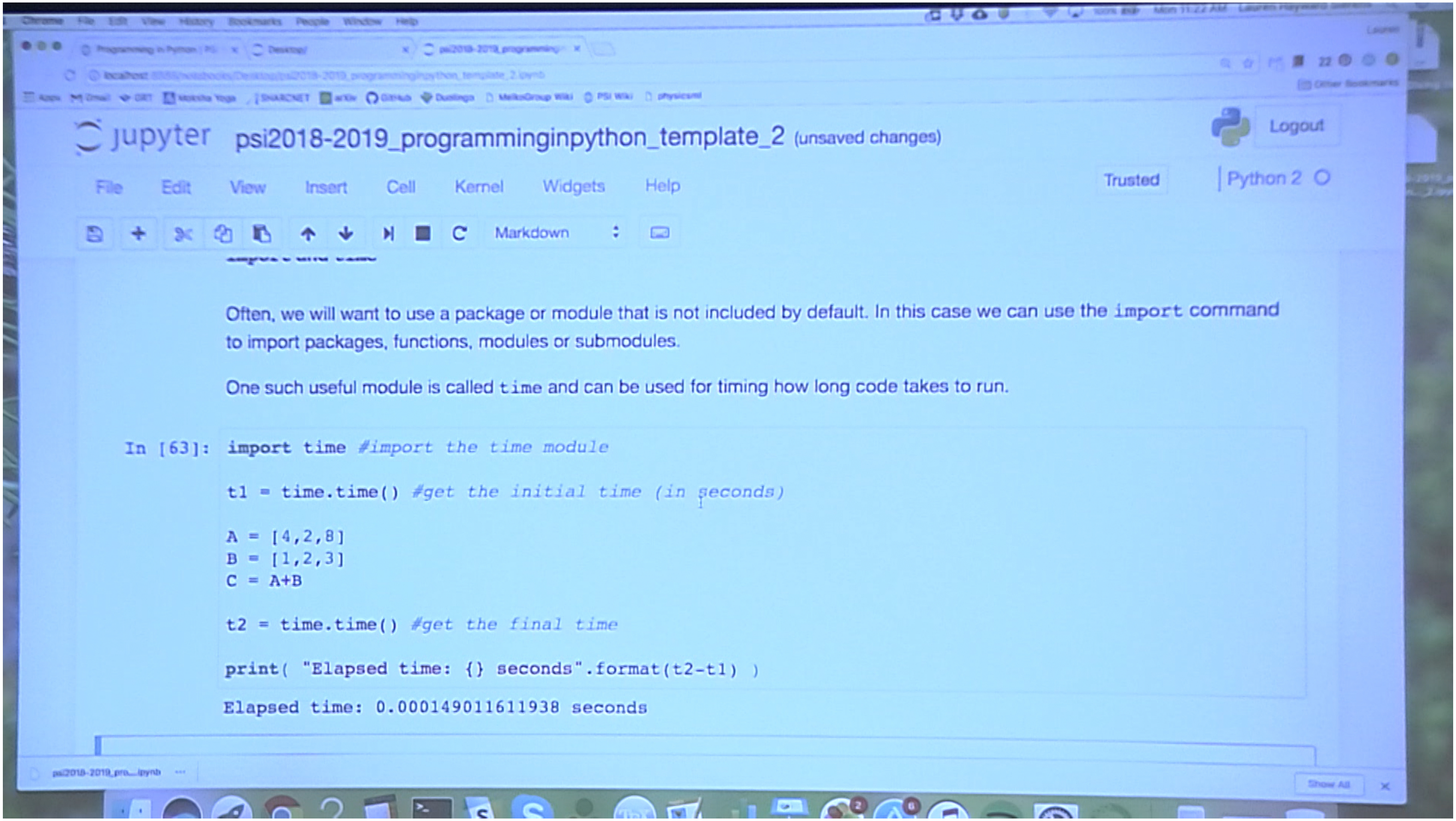
Python 2
Code
#An optional third argument is the step size:
print(range(2, 12, 5))
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
[2, 7]
import and time
Often, we will want to use a package or module that is not included by default. In this case we can use the import command to import packages, functions, modules or submodules.
One such useful module is called time and can be used for timing how long code takes to run.
In [13]: import time #import the time module
t1 = time.time()
A = [4,2,8]
B = [1,2,3]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Often, we will want to use a package or module that is not included by default. In this case we can use the import command to import packages, functions, modules or submodules.
One such useful module is called time and can be used for timing how long code takes to run.
In [63]:
import time #import the time module
t1 = time.time() #get the initial time (in seconds)
A = [4,2,8]
B = [1,2,3]
C = A+B
t2 = time.time() #get the final time
print("Elapsed time: {} seconds".format(t2-t1))
Elapsed time: 0.000149011611938 seconds

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In [63]:
```
import time #import the time module

t1 = time.time() #get the initial time (in seconds)

A = [4,2,8]
B = [1,2,3]
C = A+B

t2 = time.time() #get the final time

print( "Elapsed time: {} seconds".format(t2-t1) )
```

```
Elapsed time: 0.000149011611938 seconds
```

In [64]:
```
%%time

A = [4,2,8]
B = [1,2,3]
C = A+B
```

```
CPU times: user 8 µs, sys: 6 µs, total: 14 µs
```

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3. Control structures

3.0. `if` statement

An `if` statement is used if we want to execute some section of code only if some conditional expression is true.

For example, the code segment

```
if x:
    print("Hello")
```

will print `Hello` only if the *truth value* of `x` is true.

The truth value of `x` is false if it is has the value `None`, `False`, zero (of any numeric type), or if it is empty (or example, if it is an empty list, string or dictionary). Otherwise, the truth value of `x` is true.

```
In [ ]:
```

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3.6. if statement

An `if` statement is used if we want to execute some section of code only if some conditional expression is true.

For example, the code segment

```
if x:
    print("Hello")
```

will print `Hello` only if the *truth value* of `x` is true.

The truth value of `x` is false if it is has the value `None`, `False`, zero (of any numeric type), or if it is empty (or example, if it is an empty list, string or dictionary). Otherwise, the truth value of `x` is true.

```
In [ ]:
```

Examples of conditional expressions are:

Conditional expressions	Description
`a or b`	logical OR

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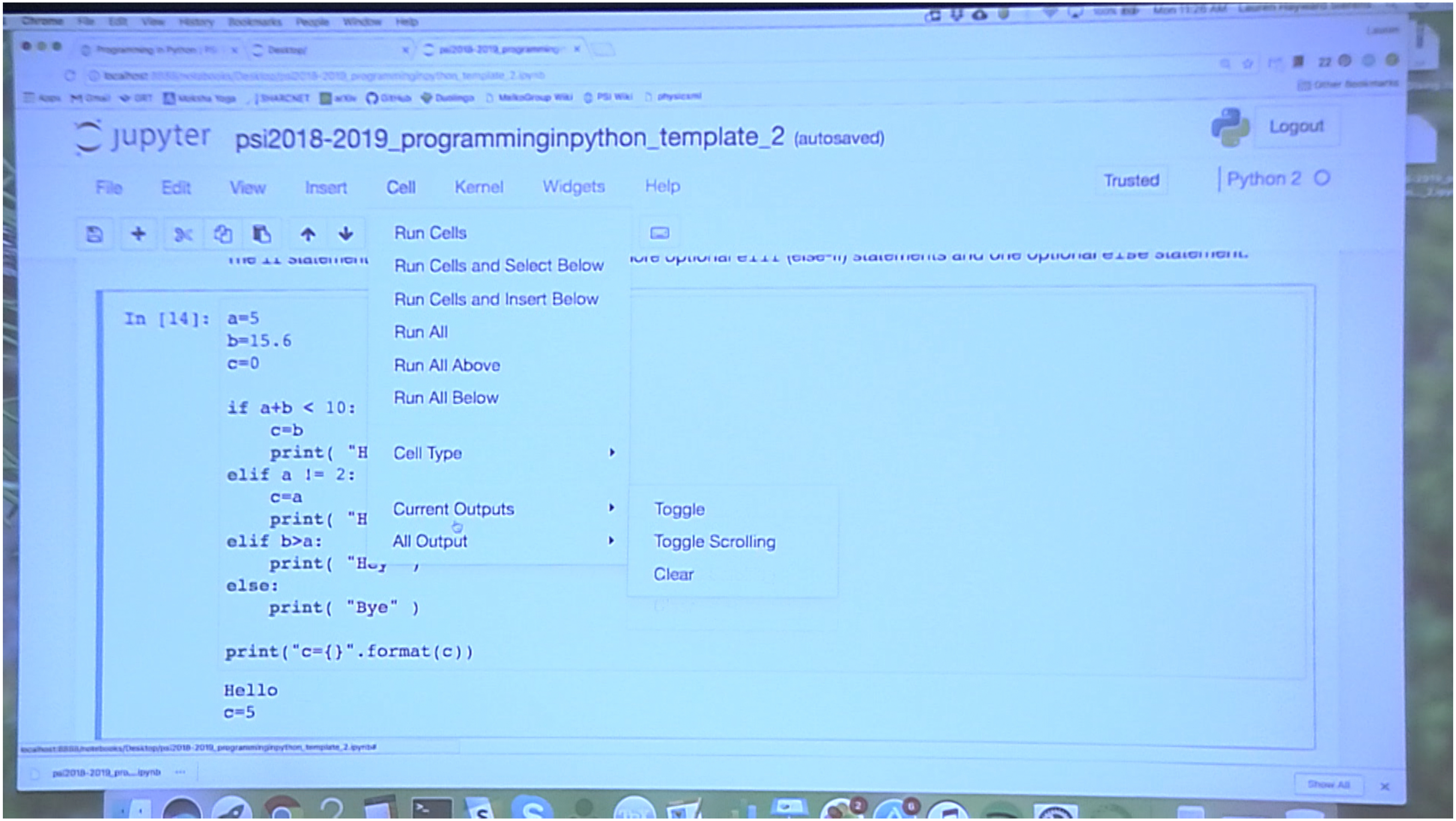
```
Hello
```

Examples of conditional expressions are:

Conditional expressions	Description
`a or b`	logical OR
`a and b`	logical AND
`not a`	logical NOT
`a < b`	less than
`a <= b`	less than or equal to
`a > b`	greater than
`a >= b`	greater than or equal to
`a == b`	equal

The `if` statement can be combined with one or more optional `elif` (else-if) statements and one optional `else` statement.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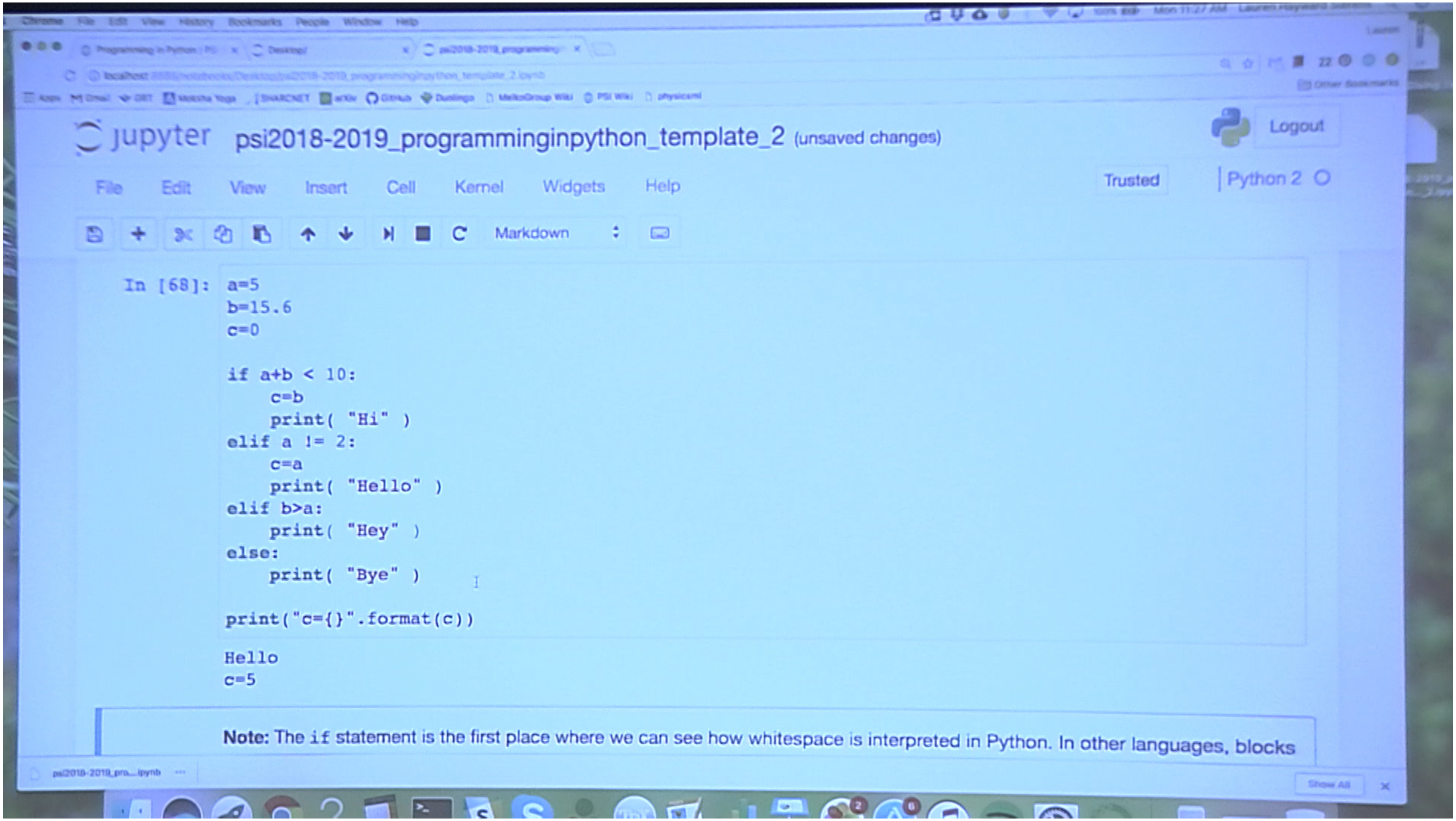
Run Cells
Run Cells and Select Below
Run Cells and Insert Below
Run All
Run All Above
Run All Below
Cell Type
Current Outputs
All Output
Toggle
Toggle Scrolling
Clear
In [14]: a=5
b=15.6
c=0
if a+b < 10:
c=b
print("H
elif a != 2:
c=a
print("H
elif b>a:
else:
print("Bye")
print("c={}".format(c))
Hello
c=5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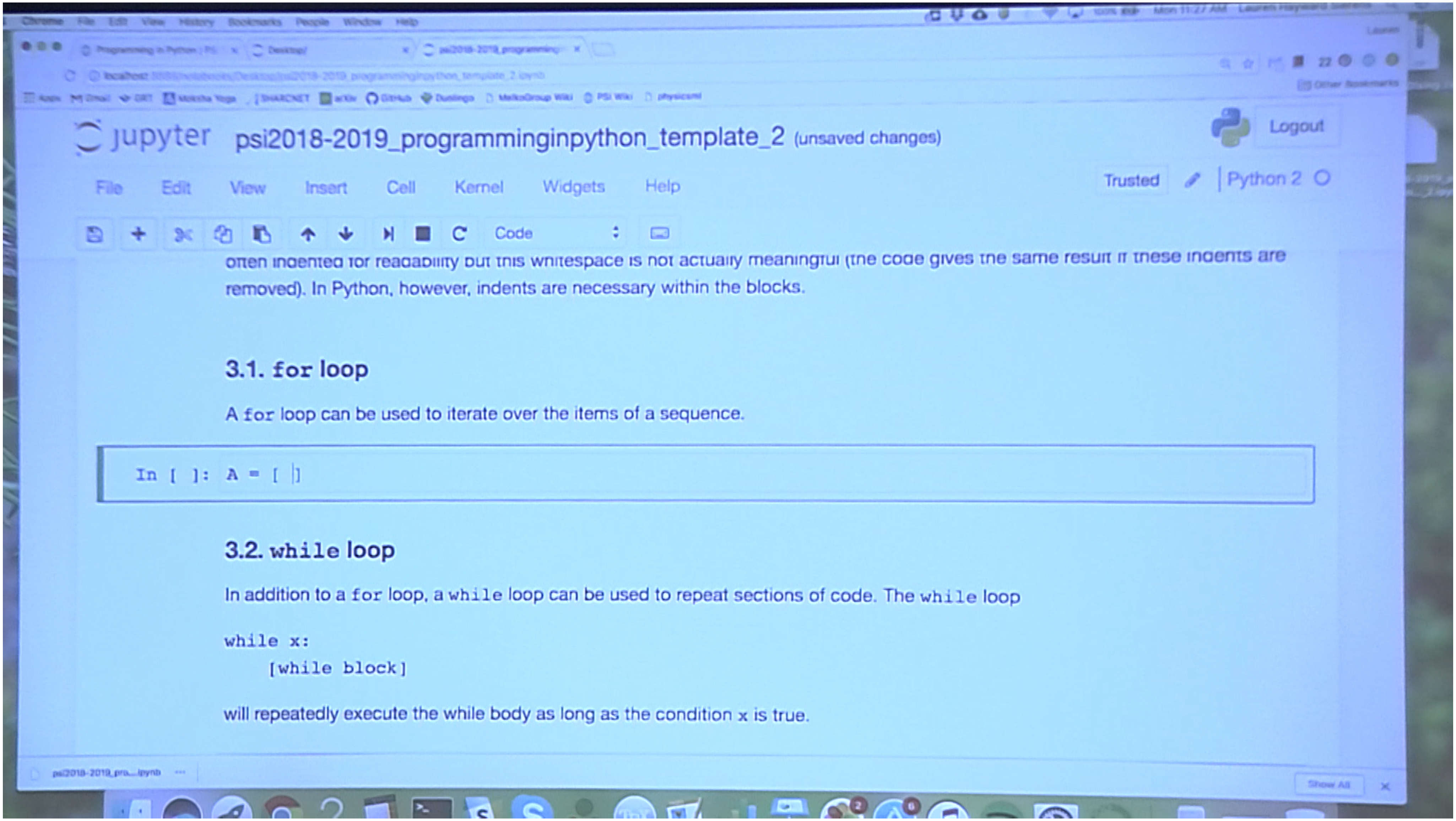
In [68]:
a=5
b=15.6
c=0
if a+b < 10:
c=b
print("Hi")
elif a != 2:
c=a
print("Hello")
elif b>a:
print("Hey")
else:
print("Bye")
print("c={}".format(c))
Hello
c=5
Note: The if statement is the first place where we can see how whitespace is interpreted in Python. In other languages, blocks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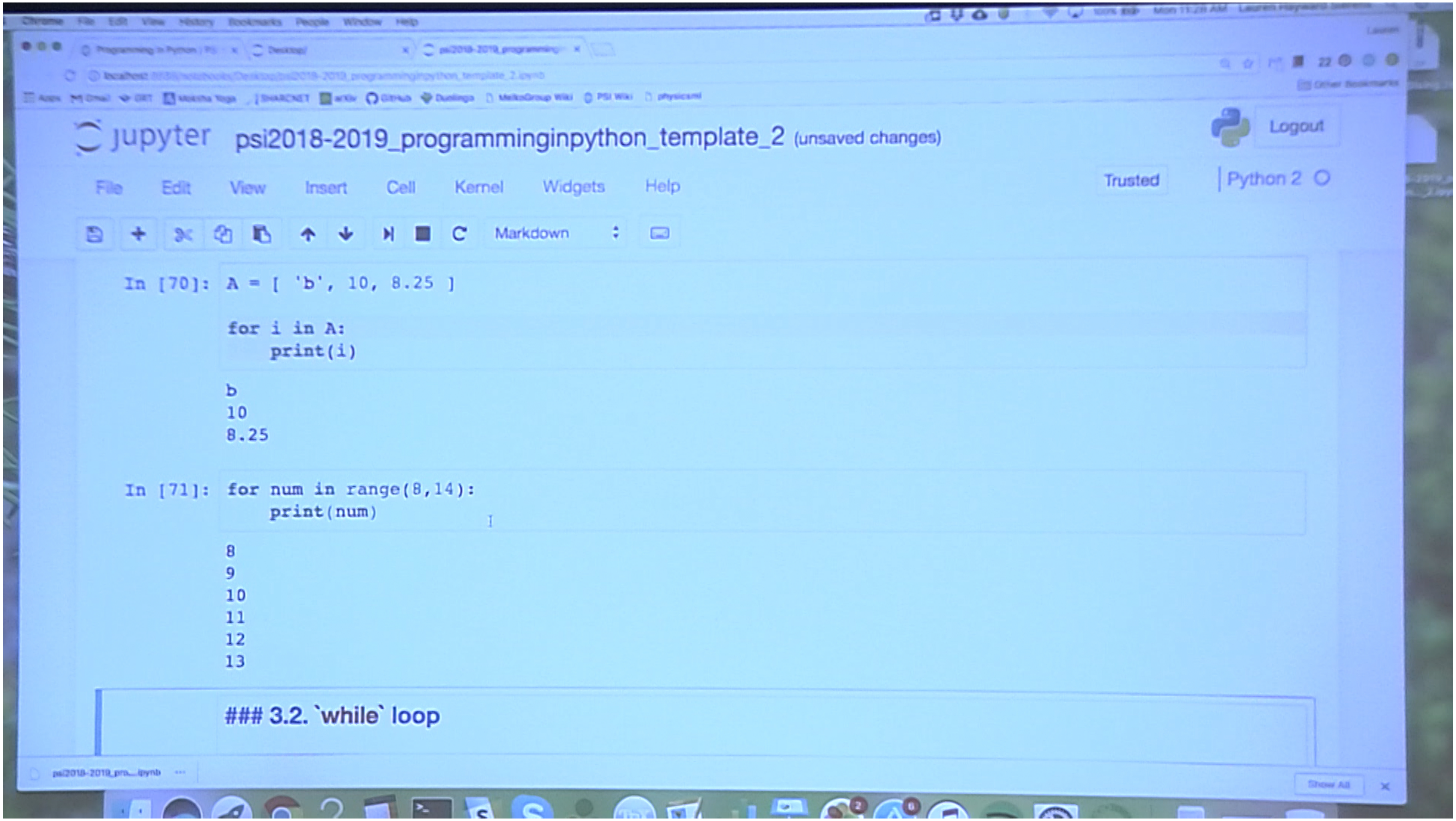
often indented for readability but this whitespace is not actually meaningful (the code gives the same result if these indents are removed). In Python, however, indents are necessary within the blocks.
3.1. for loop
A for loop can be used to iterate over the items of a sequence.
In [ ]: A = [ ]
3.2. while loop
In addition to a for loop, a while loop can be used to repeat sections of code. The while loop
while x:
[while block]
will repeatedly execute the while body as long as the condition x is true.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In [70]: A = ['b', 10, 8.25]
for i in A:
    print(i)
b
10
8.25
In [71]: for num in range(8,14):
    print(num)
8
9
10
11
12
13
3.2. `while` loop

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In addition to a `for` loop, a `while` loop can be used to repeat sections of code. The `while` loop

```
while x:
    [while block]
```

will repeatedly execute the while body as long as the condition `x` is true.

In [72]:
```
a = 10

while a>0:
    print(a)
    a = a-2
```

```
10
8
6
4
2
```

3.3 Defining functions

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```
8
6
4
2
```

3.3. Defining functions

Use the keyword `def` to define your own function. This function can then be called from other parts of your code. Optionally, your function can accept one or more input parameters. As another option, you can use a `return` statement to return one or more values from your function.

```
In [15]: #Function with no input parameters:
```

```
In [16]: #Function with two input parameters:
```

```
In [17]: #Function with one input parameter and two return values:
```

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3.3. Defining functions

Use the keyword `def` to define your own function. This function can then be called from other parts of your code. Optionally, your function can accept one or more input parameters. As another option, you can use a `return` statement to return one or more values from your function.

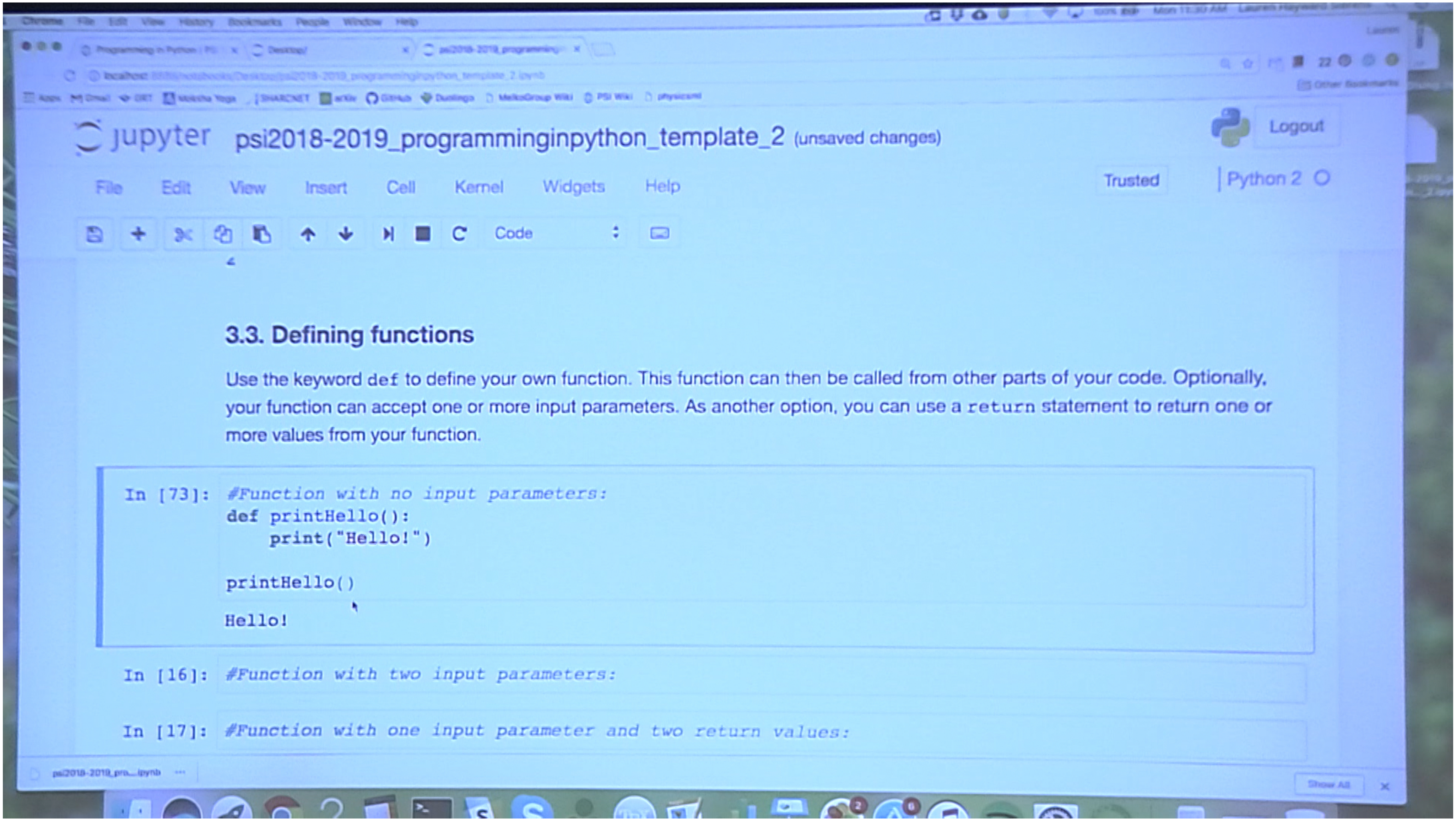
In [73]:
```
#Function with no input parameters:
def printHello():
    print("Hello!")

printHello()
```

```
Hello!
```

In [16]:
```
#Function with two input parameters:
```

In [17]:
```
#Function with one input parameter and two return values:
```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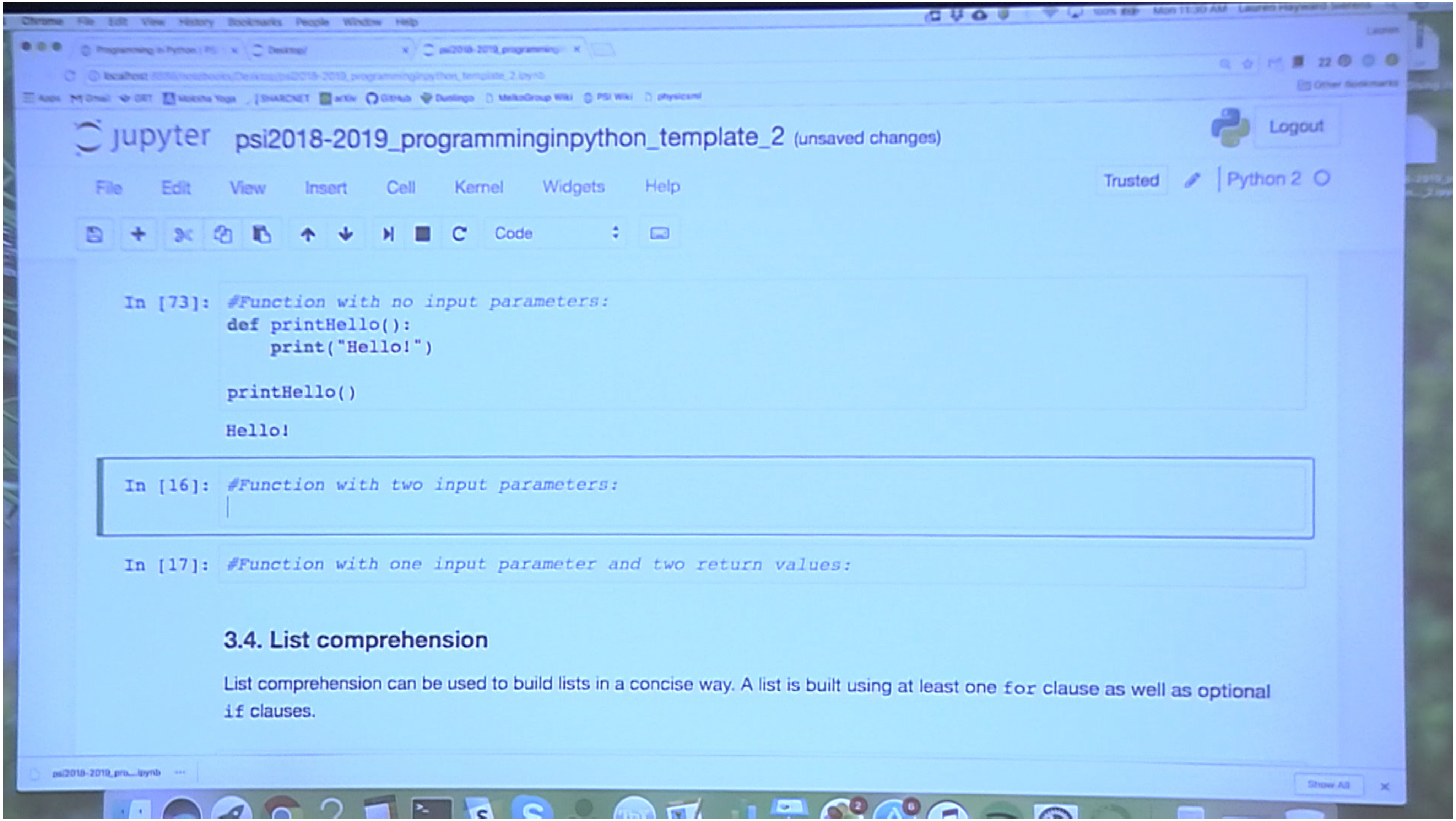
3.3. Defining functions
Use the keyword def to define your own function. This function can then be called from other parts of your code. Optionally, your function can accept one or more input parameters. As another option, you can use a return statement to return one or more values from your function.
In [73]: #Function with no input parameters:
def printHello():
    print("Hello!")
printHello()
Hello!
In [16]: #Function with two input parameters:
In [17]: #Function with one input parameter and two return values: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Code
In [73]:
#Function with no input parameters:
def printHello():
print("Hello!")
printHello()
Hello!
In [16]:
#Function with two input parameters:
In [17]:
#Function with one input parameter and two return values:
3.4. List comprehension
List comprehension can be used to build lists in a concise way. A list is built using at least one for clause as well as optional if clauses.

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Code

In [73]:
```
#Function with no input parameters:
def printHello():
    print("Hello!")

printHello()
```

```
Hello!
```

In [16]:
```
#Function with two input parameters:
def get_c(a,b):
    c = 5*a - b
```

In [17]:
```
#Function with one input parameter and two return values:
```

3.4. List comprehension

List comprehension can be used to build lists in a concise way. A list is built using at least one `for` clause as well as optional `if` clauses

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In [74]:
```
#Function with two input parameters:
def get_c(a,b):
    c = 5*a - b
    print(c)

get_c(1,2)
get_c(4.3,-2)
```

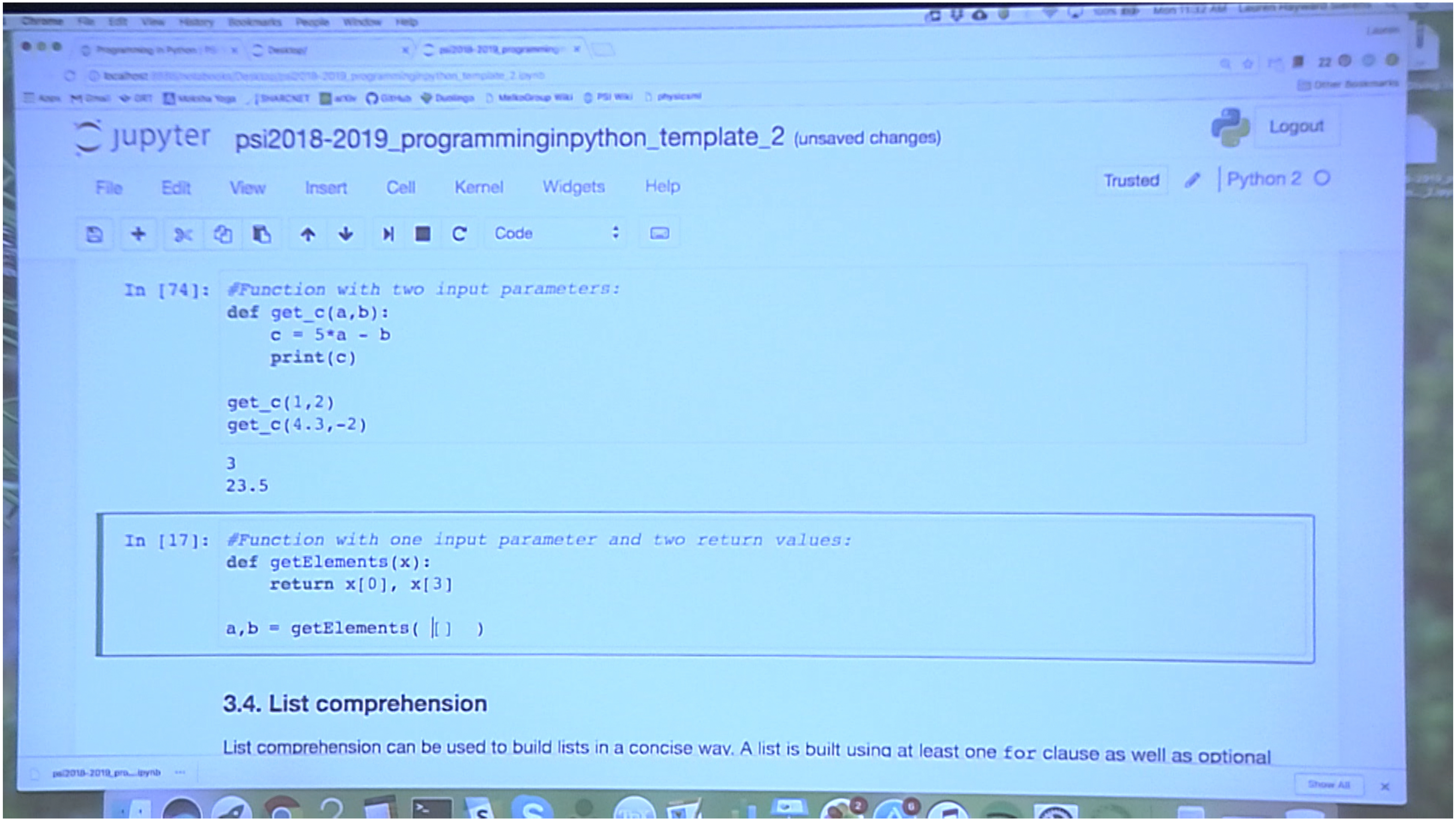
```
3
23.5
```

In [17]:
```
#Function with one input parameter and two return values:
```

3.4. List comprehension

List comprehension can be used to build lists in a concise way. A list is built using at least one `for` clause as well as optional `if` clauses.

In [ ]: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Code
In [74]:
#Function with two input parameters:
def get_c(a,b):
c = 5*a - b
print(c)
get_c(1,2)
get_c(4.3,-2)
3
23.5
In [17]:
#Function with one input parameter and two return values:
def getElements(x):
return x[0], x[3]
a,b = getElements([])
3.4. List comprehension
List comprehension can be used to build lists in a concise way. A list is built using at least one for clause as well as optional

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Code

```
def get_c(a,b):
    c = 5*a - b
    print(c)

get_c(1,2)
get_c(4.3,-2)
```

```
3
23.5
```

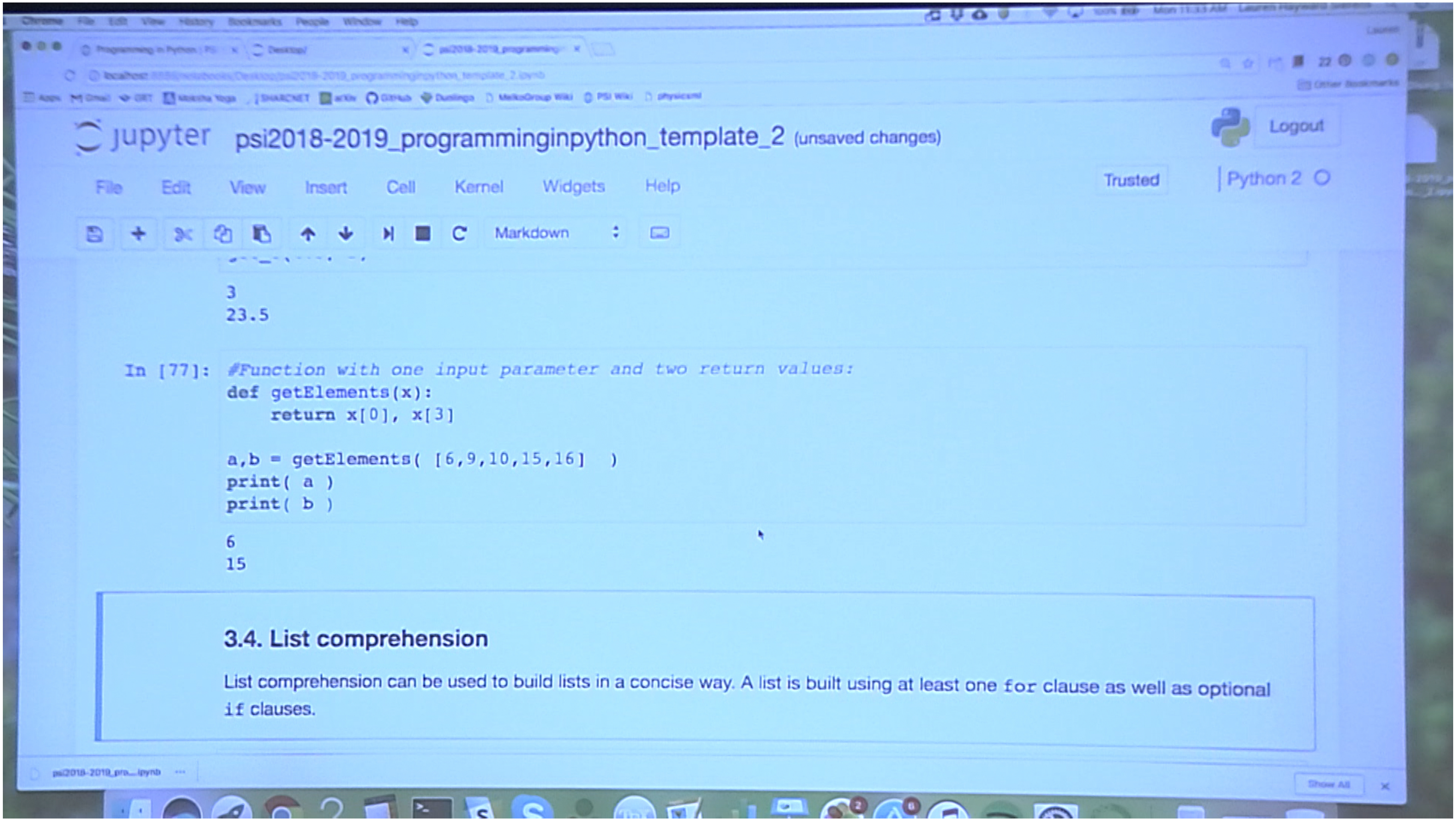
In [76]:

```
#Function with one input parameter and two return values:
def getElements(x):
    return x[0], x[3]

a,b = getElements( [6,9,10,15,16]  )
```

3.4. List comprehension

List comprehension can be used to build lists in a concise way. A list is built using at least one `for` clause as well as optional `if` clauses.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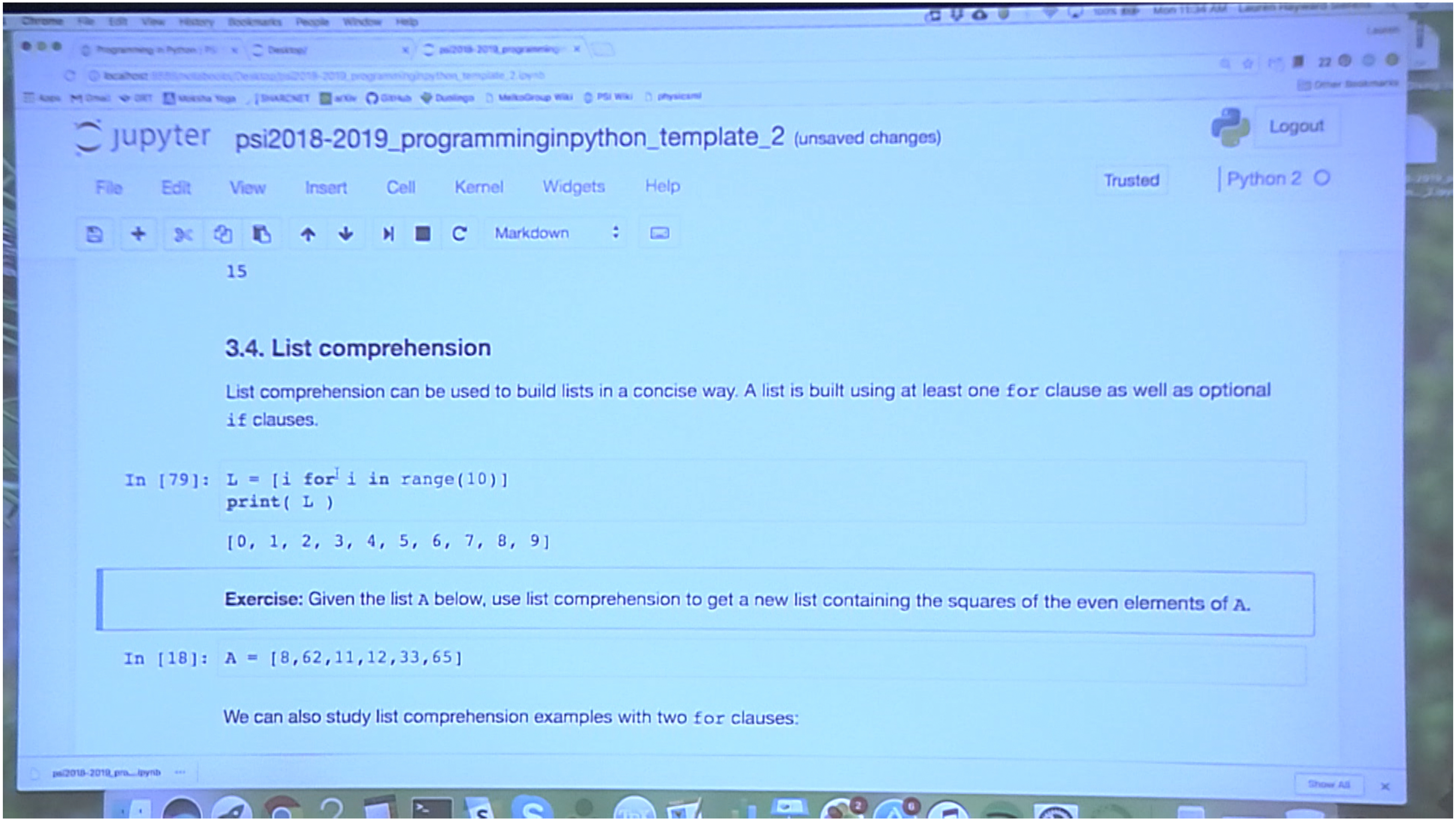
3
23.5
In [77]:
#Function with one input parameter and two return values:
def getElements(x):
    return x[0], x[3]
a,b = getElements([6,9,10,15,16])
print(a)
print(b)
6
15
3.4. List comprehension
List comprehension can be used to build lists in a concise way. A list is built using at least one for clause as well as optional if clauses.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Markdown
15
3.4. List comprehension
List comprehension can be used to build lists in a concise way. A list is built using at least one for clause as well as optional if clauses.
In [79]: L = [i for i in range(10)]
print(L)
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
Exercise: Given the list A below, use list comprehension to get a new list containing the squares of the even elements of A.
In [18]: A = [8,62,11,12,33,65]
We can also study list comprehension examples with two for clauses:

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```
15
```

3.4. List comprehension

List comprehension can be used to build lists in a concise way. A list is built using at least one `for` clause as well as optional `if` clauses.

In [79]:
```
L = [i for i in range(10)]
print( L )
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

In [ ]:
```
A = [7,-8,2,20]
B = [a*2 for a ]
```

Exercise: Given the list `A` below, use list comprehension to get a new list containing the squares of the even elements of `A`.

In [18]:
```
A = [8,62,11,12,33,65]
```

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List comprehension can be used to build lists in a concise way. A list is built using at least one `for` clause as well as optional `if` clauses.

In [79]:
```
L = [i for i in range(10)]
print( L )
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

In [81]:
```
A = [7,-8,2,20]
B = [a*2 for a in A if a>0]
print( B )
```

```
[14, 4, 40]
```

Exercise: Given the list `A` below, use list comprehension to get a new list containing the squares of the even elements of `A`.

In [18]:
```
A = [8,62,11,12,33,65]
```

We can also study list comprehension examples with two `for` clauses:

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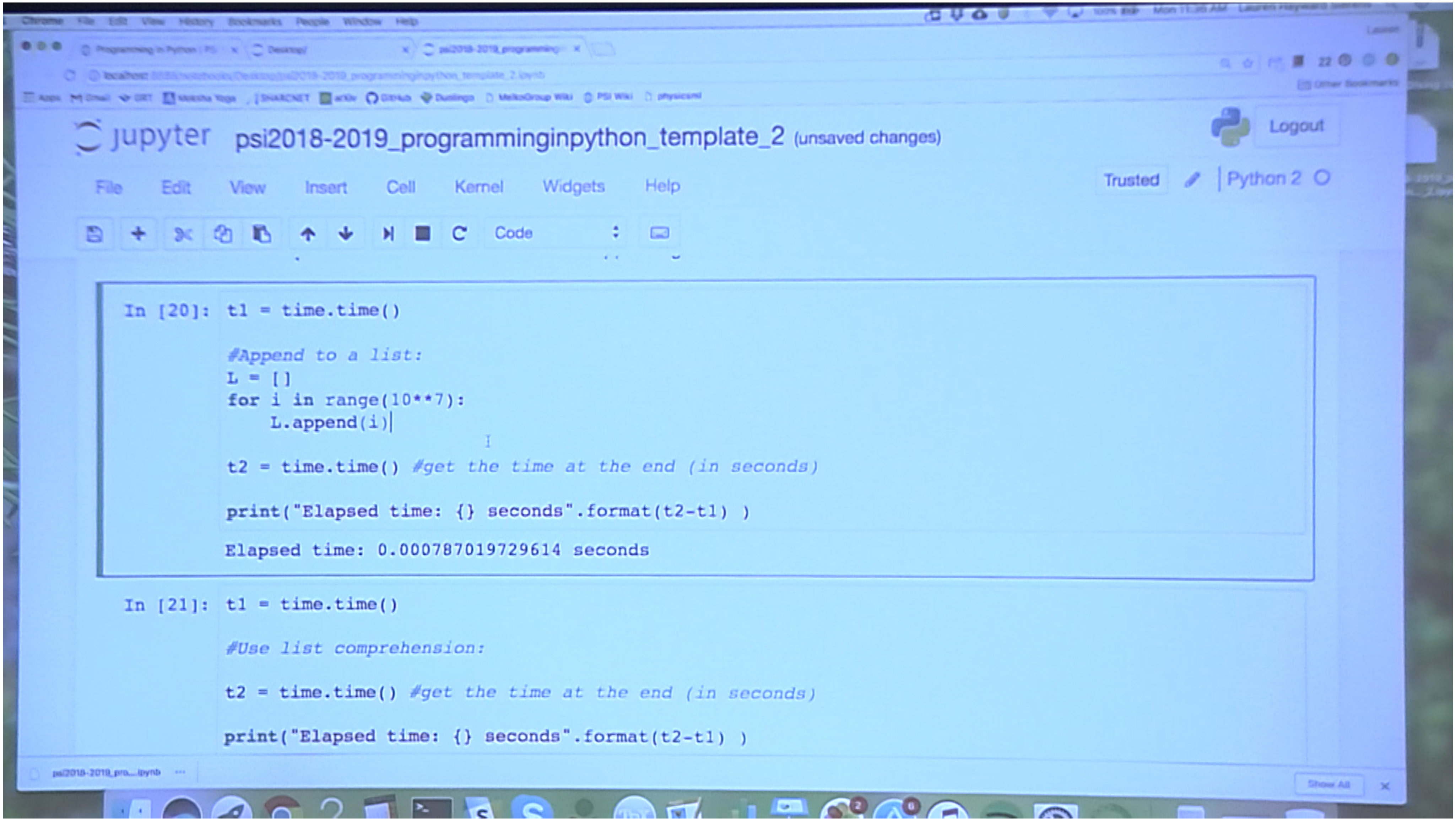
```
In [19]: A = [3,4]
         B = [4,7,11]
```

List comprehension can be much faster than appending to a list.

```
In [20]: t1 = time.time()

         #Append to a list:

         t2 = time.time() #get the time at the end (in seconds)

         print("Elapsed time: {} seconds".format(t2-t1) )

         Elapsed time: 0.000787019729614 seconds

In [21]: t1 = time.time()

         #Use list comprehension:

         t2 = time.time() #get the time at the end (in seconds)
```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In [20]:
t1 = time.time()

#Append to a list:
L = []
for i in range(10**7):
    L.append(i)

t2 = time.time() #get the time at the end (in seconds)

print("Elapsed time: {} seconds".format(t2-t1))
Elapsed time: 0.000787019729614 seconds
In [21]:
t1 = time.time()

#Use list comprehension:

t2 = time.time() #get the time at the end (in seconds)

print("Elapsed time: {} seconds".format(t2-t1))

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```
print("Elapsed time: {} seconds".format(t2-t1) )
```

Elapsed time: 1.53906798363 seconds

In [83]:
```
t1 = time.time()

#Use list comprehension:
L = [i for i in range(10**7)]

t2 = time.time() #get the time at the end (in seconds)

print("Elapsed time: {} seconds".format(t2-t1) )
```

Elapsed time: 1.12796211243 seconds

4. The NumPy package

Here we will explore some of the scientific computing functionality available through the NumPy package.

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```
print("Elapsed time: {} seconds".format(t2-t1) )
```

```
Elapsed time: 1.12796211243 seconds
```

4. The NumPy package

Here we will explore some of the scientific computing functionality available through the NumPy package.

Whenever we want to use NumPy, we must first import it. A standard convention is to import it under the name `np`.

```
In [22]: import numpy as np
```

4.0. Arrays

The most common objects in NumPy are single- or multi-dimensional arrays. Arrays are tables of values that all have the same type. Here we will only consider arrays of numbers.

There are various functions available for creating NumPy arrays.

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Whenever we want to use NumPy, we must first import it. A standard convention is to import it under the name `np`.

In [84]:
```
import numpy as np
```

4.0. Arrays

The most common objects in NumPy are single- or multi-dimensional arrays. Arrays are tables of values that all have the same type. Here we will only consider arrays of numbers.

There are various functions available for creating NumPy arrays.

In [23]:
```
#Create arrays from other data structures such as lists:
```

In [24]:
```
#Use np.zeros to create arrays of zeros of different sizes and dimensions.
#Similarly, use np.ones to create arrays of ones.
```

In [25]:
```
#Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
```

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Code

type. Here we will only consider arrays of numbers.

There are various functions available for creating NumPy arrays.

In [88]:
```
#Create arrays from other data structures such as lists:
A = np.array( [5,-2,13] ) #1D array
print( A )
print

B = np.array( [[5,-2,13], [2,2.2, 3.6]] ) #2D array
print( B )
```

```
[ 5 -2 13]

[[ 5.  -2.  13. ]
 [ 2.   2.2  3.6]]
```

In [24]:
```
#Use np.zeros to create arrays of zeros of different sizes and dimensions.
#Similarly, use np.ones to create arrays of ones.
```

In [25]:
```
#Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
```

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```
[ 2.   2.2  3.6]]
```

In [89]:
```
#Use np.zeros to create arrays of zeros of different sizes and dimensions.
#Similarly, use np.ones to create arrays of ones.

np.zeros(3)
```

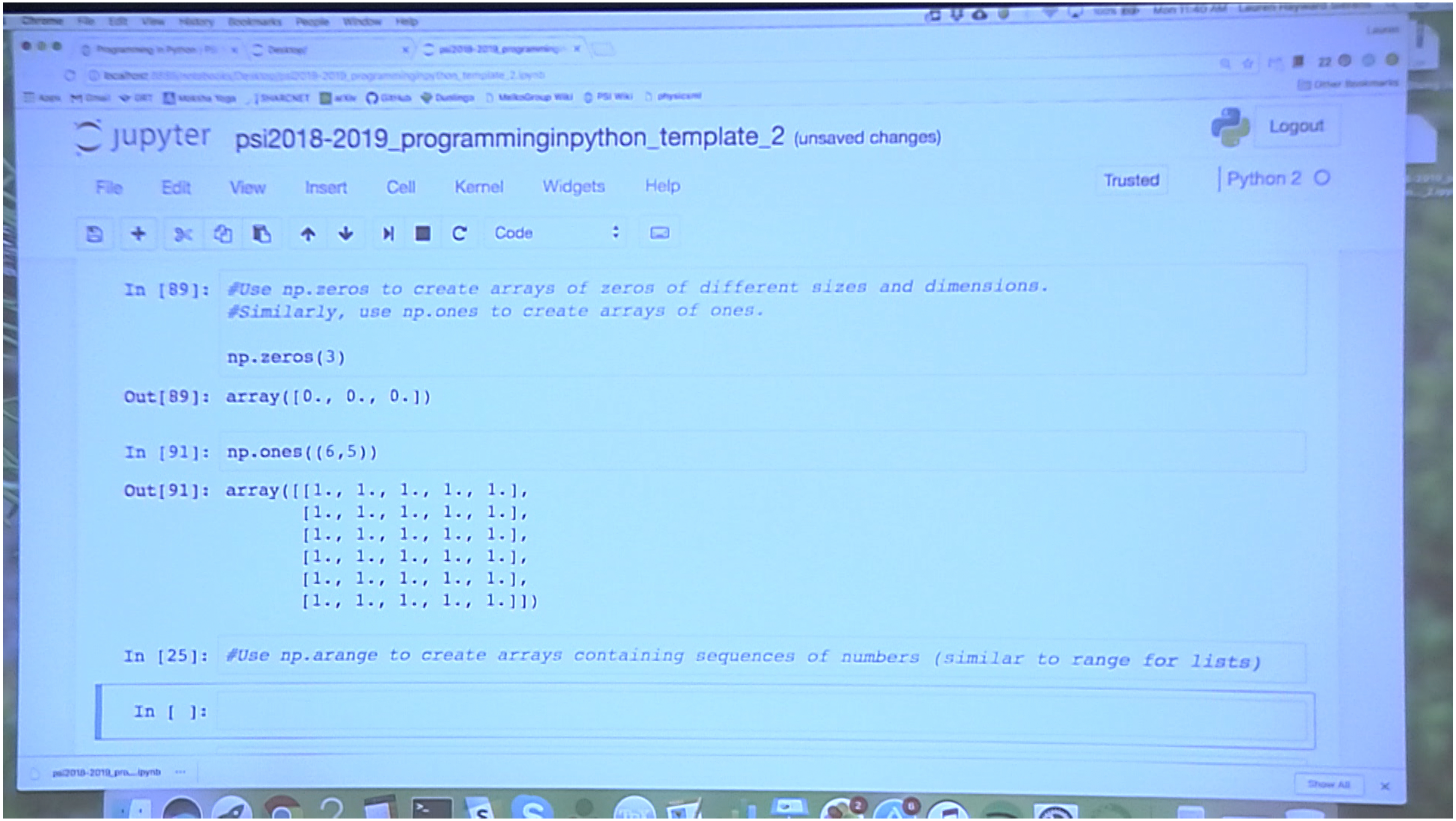
Out[89]:
```
array([0., 0., 0.])
```

In [90]:
```
np.zeros((6,5))
```

Out[90]:
```
array([[0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0.]])
```

In [25]:
```
#Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
```

In [26]:
```
#Use np.linspace get an array of linearly spaced numbers between given endpoints
```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Code
In [89]: #Use np.zeros to create arrays of zeros of different sizes and dimensions.
#Similarly, use np.ones to create arrays of ones.
np.zeros(3)
Out[89]: array([0., 0., 0.])
In [91]: np.ones((6,5))
Out[91]: array([[1., 1., 1., 1., 1.],
[1., 1., 1., 1., 1.],
[1., 1., 1., 1., 1.],
[1., 1., 1., 1., 1.],
[1., 1., 1., 1., 1.],
[1., 1., 1., 1., 1.]])
In [25]: #Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
In [ ]:

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```
Out[91]: array([[1., 1., 1., 1., 1.],
                [1., 1., 1., 1., 1.],
                [1., 1., 1., 1., 1.],
                [1., 1., 1., 1., 1.],
                [1., 1., 1., 1., 1.],
                [1., 1., 1., 1., 1.]])
```

```
In [25]: #Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
```

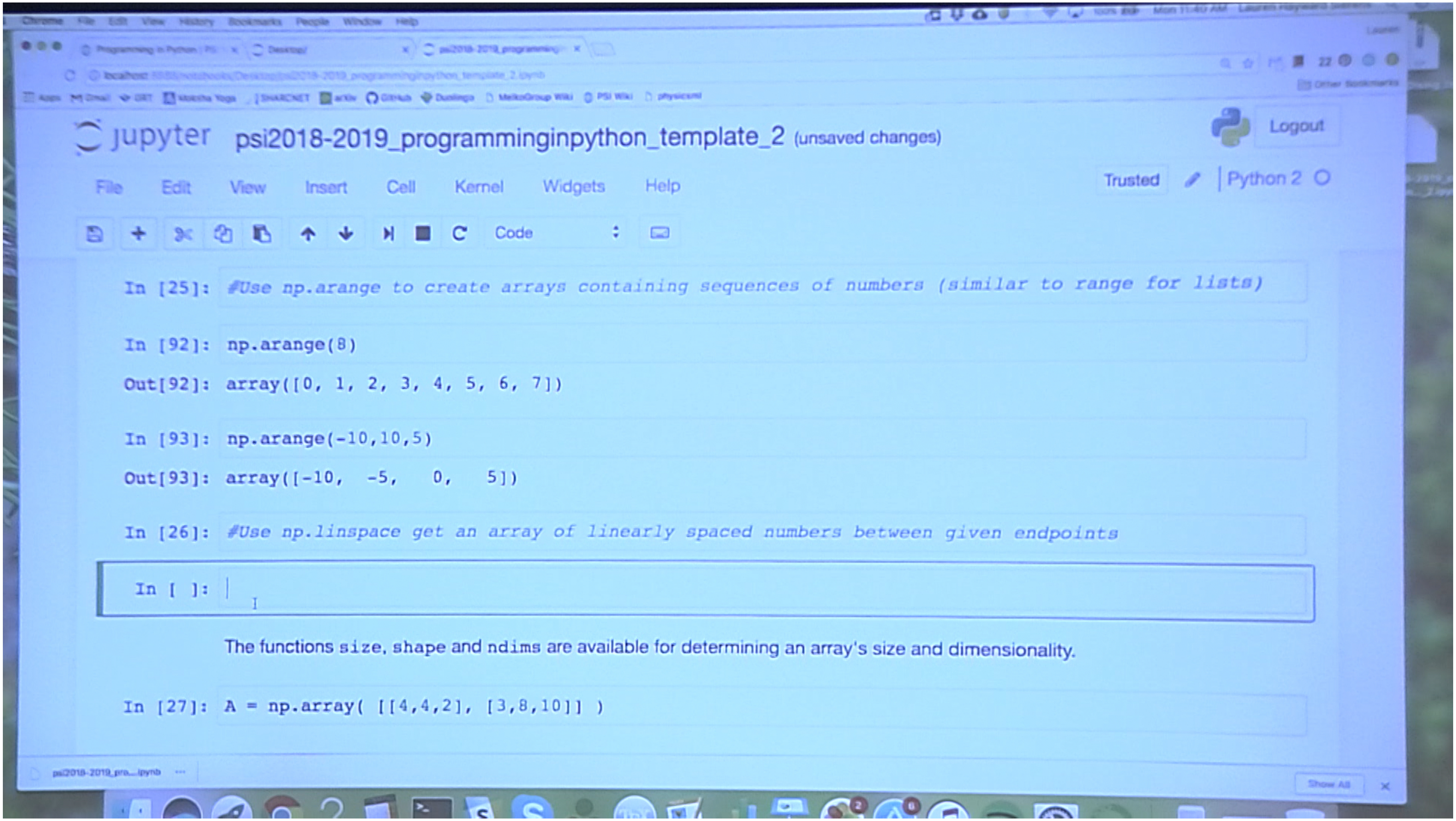
```
In [92]: np.arange(8)

Out[92]: array([0, 1, 2, 3, 4, 5, 6, 7])
```

```
In [93]: np.arange(-10,10,5)

Out[93]: array([-10,  -5,   0,   5])
```

```
In [26]: #Use np.linspace get an array of linearly spaced numbers between given endpoints
```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Code
In [25]: #Use np.arange to create arrays containing sequences of numbers (similar to range for lists)
In [92]: np.arange(8)
Out[92]: array([0, 1, 2, 3, 4, 5, 6, 7])
In [93]: np.arange(-10,10,5)
Out[93]: array([-10, -5, 0, 5])
In [26]: #Use np.linspace get an array of linearly spaced numbers between given endpoints
In [ ]:
The functions size, shape and ndims are available for determining an array's size and dimensionality.
In [27]: A = np.array([[4,4,2], [3,8,10]])

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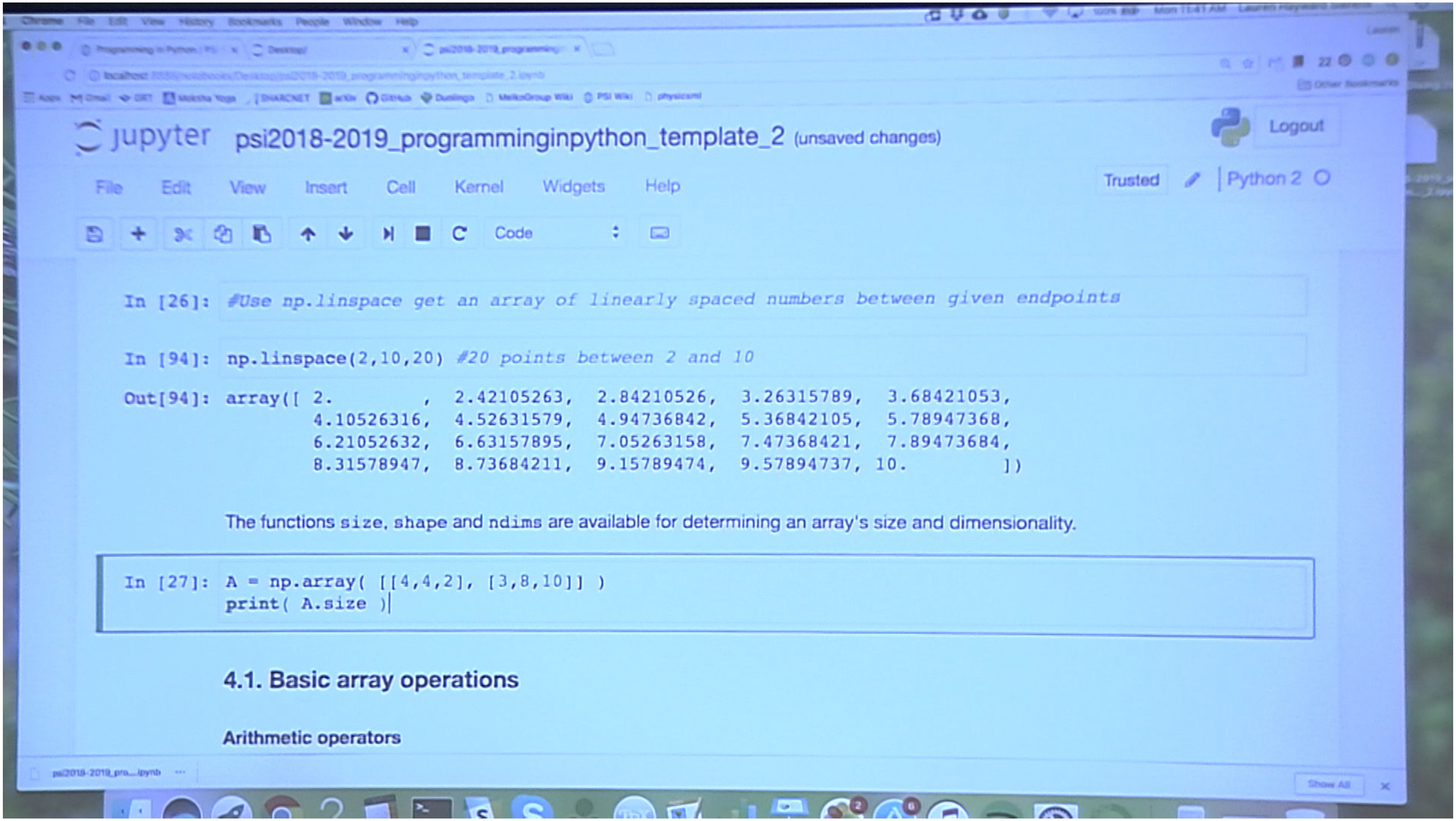
```
Out[92]: array([0, 1, 2, 3, 4, 5, 6, 7])

In [93]: np.arange(-10,10,5)

Out[93]: array([-10,  -5,   0,   5])

In [26]: #Use np.linspace get an array of linearly spaced numbers between given endpoints

In [94]: np.linspace(2,10,20) #20 points between 2 and 10

Out[94]: array([ 2.        ,  2.42105263,  2.84210526,  3.26315789,  3.68421053,
                 4.10526316,  4.52631579,  4.94736842,  5.36842105,  5.78947368,
                 6.21052632,  6.63157895,  7.05263158,  7.47368421,  7.89473684,
                 8.31578947,  8.73684211,  9.15789474,  9.57894737, 10.        ])
```

The functions `size`, `shape` and `ndims` are available for determining an array's size and dimensionality.

```
In [27]: A = np.array( [[4,4,2], [3,8,10]] )
```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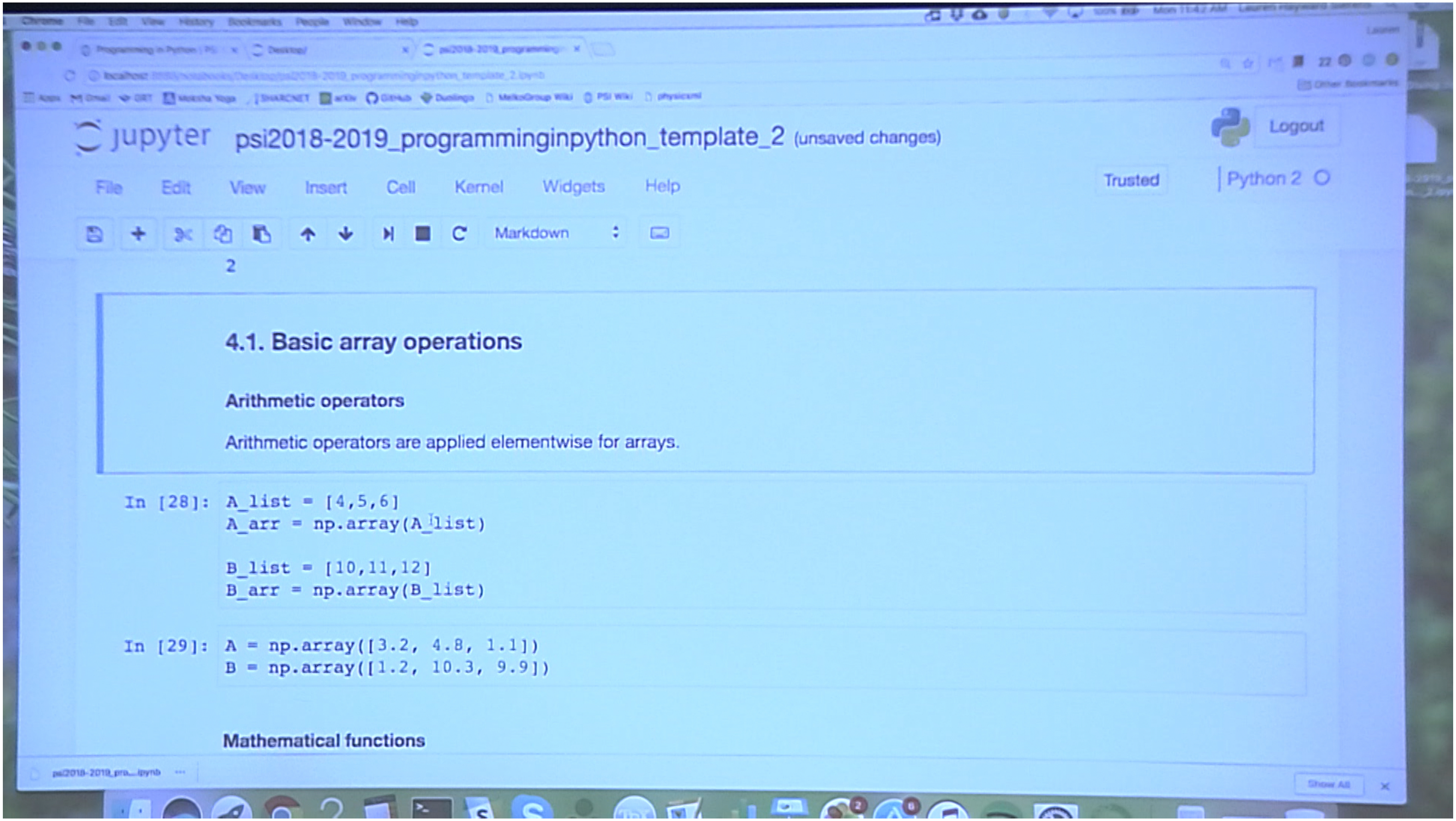
Code
In [26]: #Use np.linspace get an array of linearly spaced numbers between given endpoints
In [94]: np.linspace(2,10,20) #20 points between 2 and 10
Out[94]: array([2. , 2.42105263, 2.84210526, 3.26315789, 3.68421053,
4.10526316, 4.52631579, 4.94736842, 5.36842105, 5.78947368,
6.21052632, 6.63157895, 7.05263158, 7.47368421, 7.89473684,
8.31578947, 8.73684211, 9.15789474, 9.57894737, 10.])
The functions size, shape and ndims are available for determining an array's size and dimensionality.
In [27]: A = np.array([[4,4,2], [3,8,10]])
print(A.size)
4.1. Basic array operations
Arithmetic operators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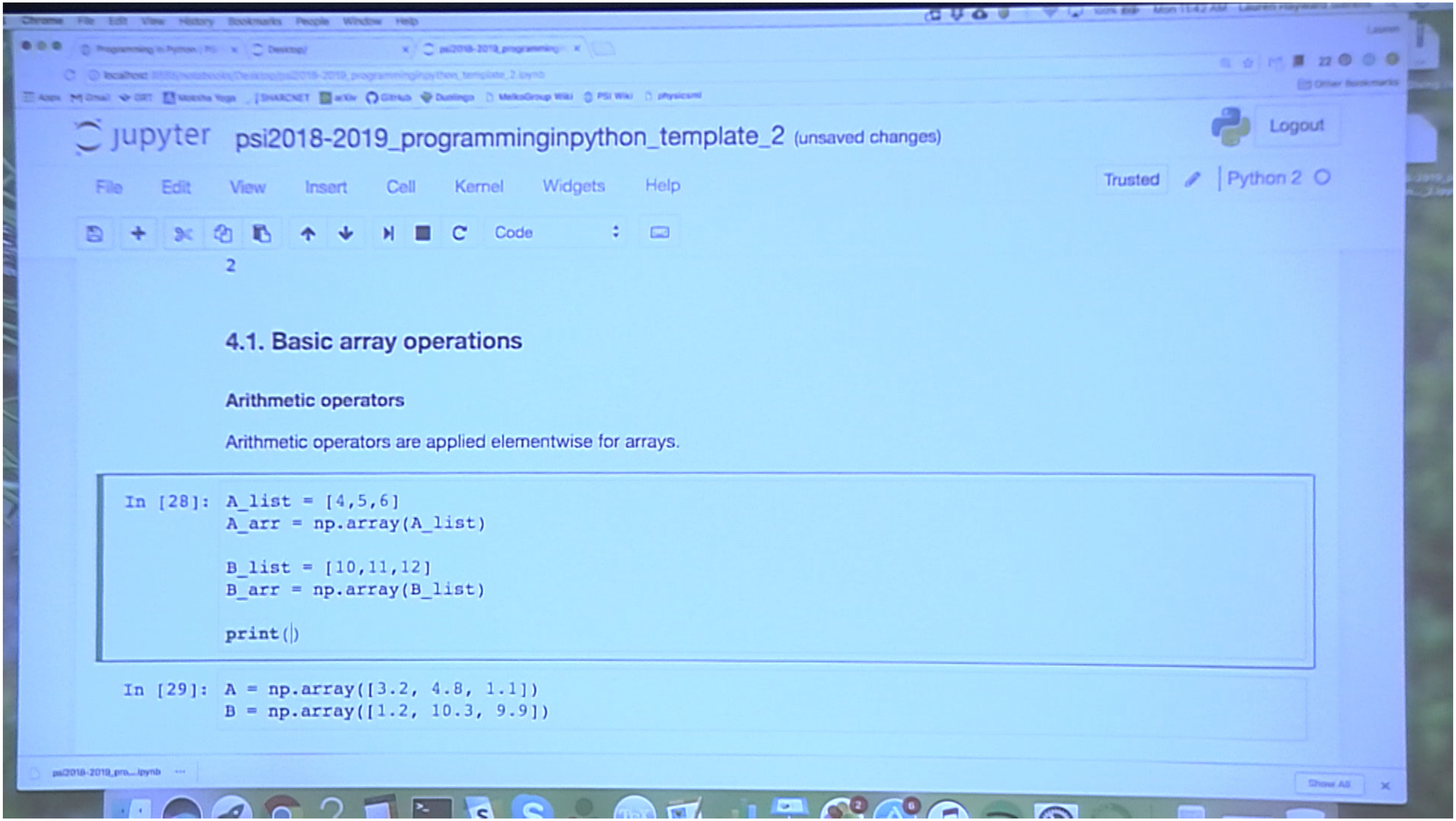
4.1. Basic array operations
Arithmetic operators
Arithmetic operators are applied elementwise for arrays.
In [28]: A_list = [4,5,6]
A_arr = np.array(A_list)
B_list = [10,11,12]
B_arr = np.array(B_list)
In [29]: A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])
Mathematical functions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2
4.1. Basic array operations
Arithmetic operators
Arithmetic operators are applied elementwise for arrays.
In [28]:
A_list = [4,5,6]
A_arr = np.array(A_list)
B_list = [10,11,12]
B_arr = np.array(B_list)
print()
In [29]:
A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])

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4.1. Basic array operations

Arithmetic operators

Arithmetic operators are applied elementwise for arrays.

In [99]:
```
A_list = [4,5,6]
A_arr = np.array(A_list)

B_list = [10,11,12]
B_arr = np.array(B_list)

print( A_list + B_list )
print( A_arr + B_arr )
```

```
[4, 5, 6, 10, 11, 12]
[14 16 18]
```

In [29]:
```
A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])
```

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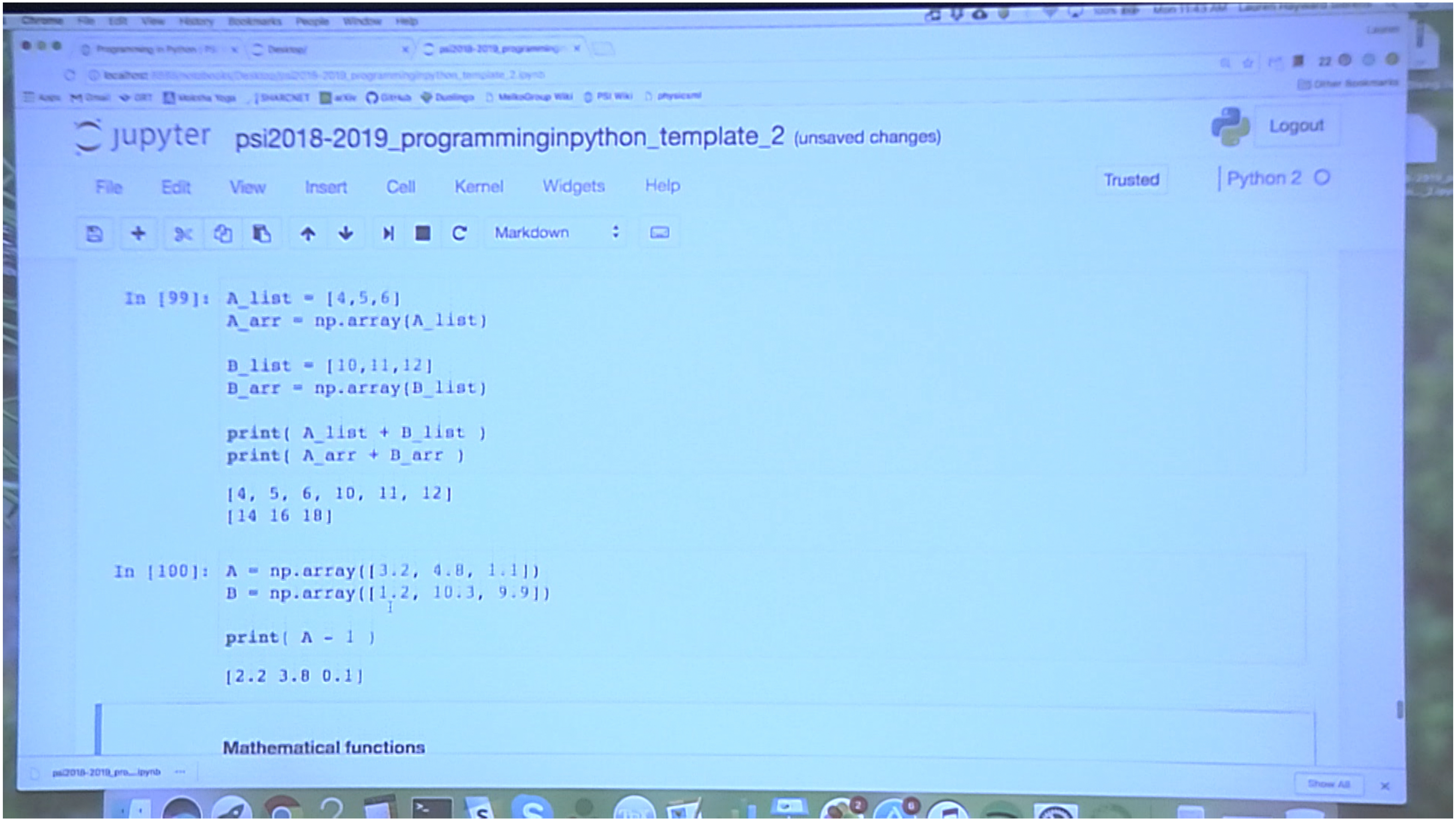
Mathematical functions

Numpy has several built-in mathematical functions that act elementwise on arrays `x`, such as:

NumPy function	Description
`np.sqrt(x)`	elementwise square-root
`np.exp(x)`	elementwise exponential
`np.log(x)`	elementwise natural logarithm
`np.abs(x)`	elementwise absolute value
`np.sin(x)`	elementwise sine
`np.cos(x)`	elementwise cosine
`np.tan(x)`	elementwise tangent
`np.arcsin(x)`	elementwise inverse sine
`np.arccos(x)`	elementwise inverse cosine
`np.arctan(x)`	elementwise inverse tangent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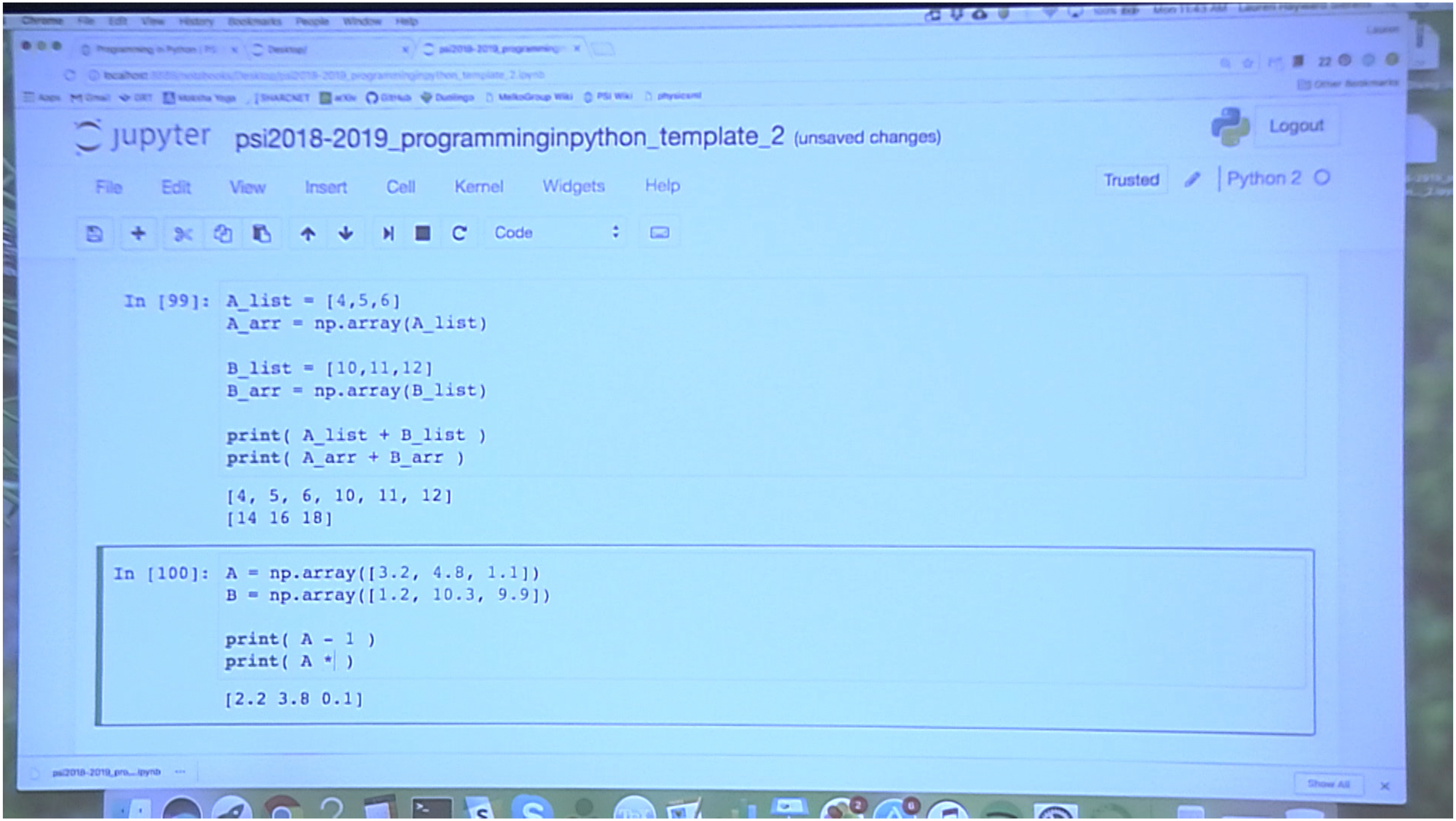
In [99]: A_list = [4,5,6]
A_arr = np.array(A_list)
B_list = [10,11,12]
B_arr = np.array(B_list)
print(A_list + B_list)
print(A_arr + B_arr)
[4, 5, 6, 10, 11, 12]
[14 16 18]
In [100]: A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])
print(A - 1)
[2.2 3.8 0.1]
Mathematical functions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Code
In [99]: A_list = [4,5,6]
A_arr = np.array(A_list)
B_list = [10,11,12]
B_arr = np.array(B_list)
print(A_list + B_list)
print(A_arr + B_arr)
[4, 5, 6, 10, 11, 12]
[14 16 18]
In [100]: A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])
print(A - 1)
print(A *)
[2.2 3.8 0.1]

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```
B_list = [10,11,12]
B_arr = np.array(B_list)

print( A_list + B_list )
print( A_arr + B_arr )
```

```
[4, 5, 6, 10, 11, 12]
[14 16 18]
```

In [101]:
```
A = np.array([3.2, 4.8, 1.1])
B = np.array([1.2, 10.3, 9.9])

print( A - 1 )
print( A * B )
```

```
[2.2 3.8 0.1]
[ 3.84 49.44 10.8
```

Mathematical functio

Numpy has several bu cal functions that act elementwise on arrays x, such as:

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`np.sqrt(x)`	elementwise square-root
`np.exp(x)`	elementwise exponential
`np.log(x)`	elementwise natural logarithm
`np.abs(x)`	elementwise absolute value
`np.sin(x)`	elementwise sine
`np.cos(x)`	elementwise cosine
`np.tan(x)`	elementwise tangent
`np.arcsin(x)`	elementwise inverse sine
`np.arccos(x)`	elementwise inverse cosine
`np.arctan(x)`	elementwise inverse tangent

In [30]:
```
x = np.array([0.2, 1.2, 0.56, 2.1])

print( np.sq)
```

Some other useful mathematical functions for mathematics and statistics are:

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Numpy has several built-in mathematical functions that act elementwise on arrays x, such as:

NumPy function	Description
`np.sqrt(x)`	elementwise square-root
`np.exp(x)`	elementwise exponential
`np.log(x)`	elementwise natural logarithm
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`np.sin(x)`	elementwise sine
`np.cos(x)`	elementwise cosine
`np.tan(x)`	elementwise tangent
`np.arcsin(x)`	elementwise inverse sine
`np.arccos(x)`	elementwise inverse cosine
`np.arctan(x)`	elementwise inverse tangent

```
In [104]: x = np.array([0.2, 1.2, 0.56, 2.1])
```

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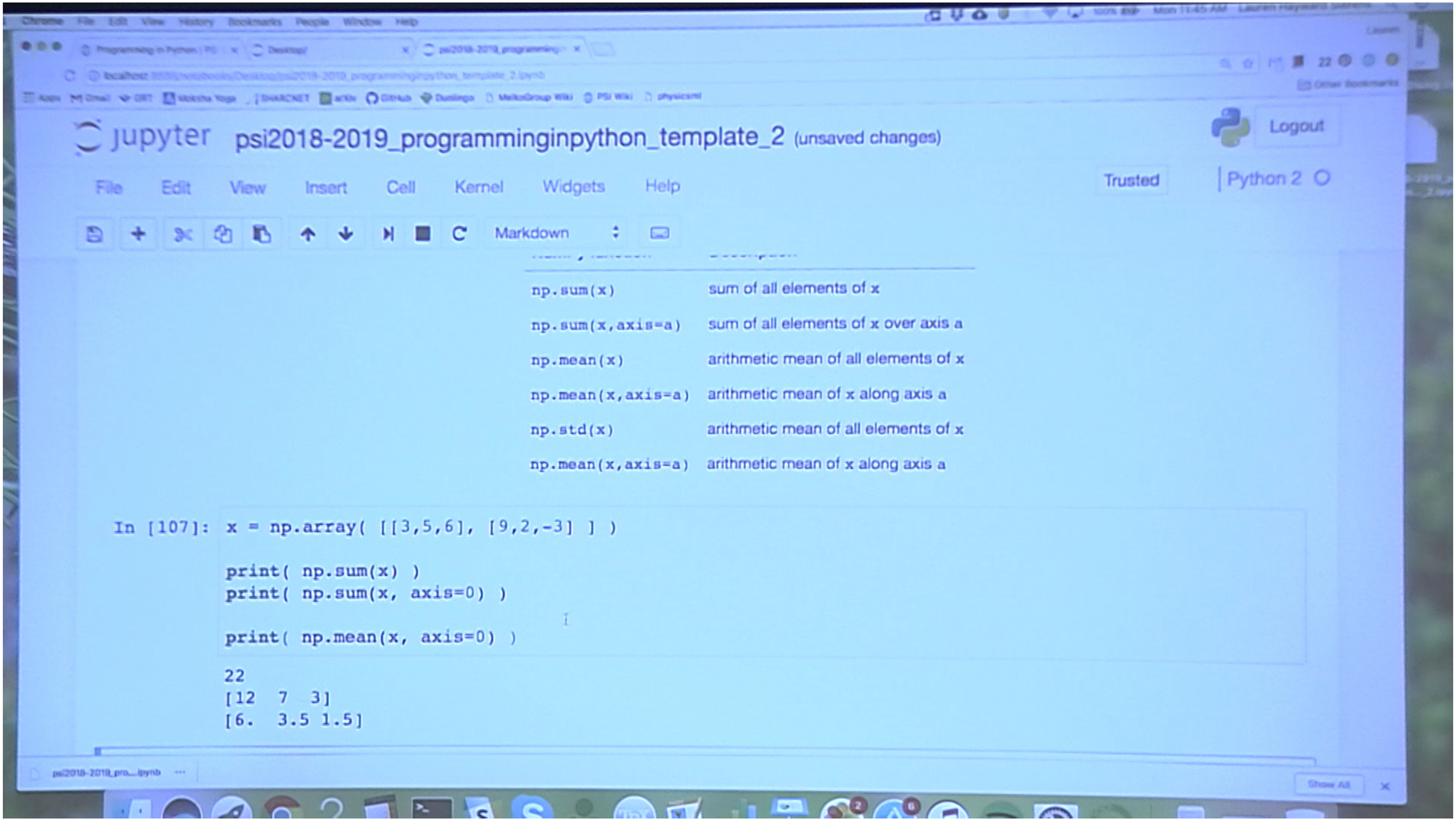
NumPy function	Description
`np.sum(x)`	sum of all elements of x
`np.sum(x,axis=a)`	sum of all elements of x over axis a
`np.mean(x)`	arithmetic mean of all elements of x
`np.mean(x,axis=a)`	arithmetic mean of x along axis a
`np.std(x)`	arithmetic mean of all elements of x
`np.mean(x,axis=a)`	arithmetic mean of x along axis a

```
In [31]: x = np.array( [[3,5,6], [9,2,-3]] )

         print( np.sum(x) )
```

Exercise: Define a function that will take as input two NumPy arrays of the same size and output the elementwise sum of their squared elements.

```
In [ ]:
```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np.sum(x) sum of all elements of x
np.sum(x,axis=a) sum of all elements of x over axis a
np.mean(x) arithmetic mean of all elements of x
np.mean(x,axis=a) arithmetic mean of x along axis a
np.std(x) arithmetic mean of all elements of x
np.mean(x,axis=a) arithmetic mean of x along axis a
In [107]: x = np.array([[3,5,6], [9,2,-3]])
print(np.sum(x))
print(np.sum(x, axis=0))
print(np.mean(x, axis=0))
22
[12 7 3]
[6. 3.5 1.5]

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`np.sum(x,axis=a)`	sum of all elements of x over axis a
`np.mean(x)`	arithmetic mean of all elements of x
`np.mean(x,axis=a)`	arithmetic mean of x along axis a
`np.std(x)`	arithmetic mean of all elements of x
`np.mean(x,axis=a)`	arithmetic mean of x along axis a

In [107]:

```
x = np.array( [[3,5,6], [9,2,-3] ] )

print( np.sum(x) )
print( np.sum(x, axis=0) )

print( np.mean(x, axis=0) )
print( np.mean(x, axis=0) )
```

```
22
[12  7  3]
[6.  3.5 1.5]
```

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`np.mean(x,axis=a)` arithmetic mean of x along axis a

```
In [109]: x = np.array( [[3,5,6], [9,2,-3] ] )

          print( np.sum(x) )
          print( np.sum(x, axis=0) )

          print( np.mean(x, axis=0) )

          print( np.std(x) )

22
[12  7  3]
[6.  3.5 1.5]
3.7267799624996494
```

Exercise: Define a function that will take as input two NumPy arrays of the same size and output the elementwise sum of their squared elements.

```
In [ ]:
```

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4.2. Random numbers

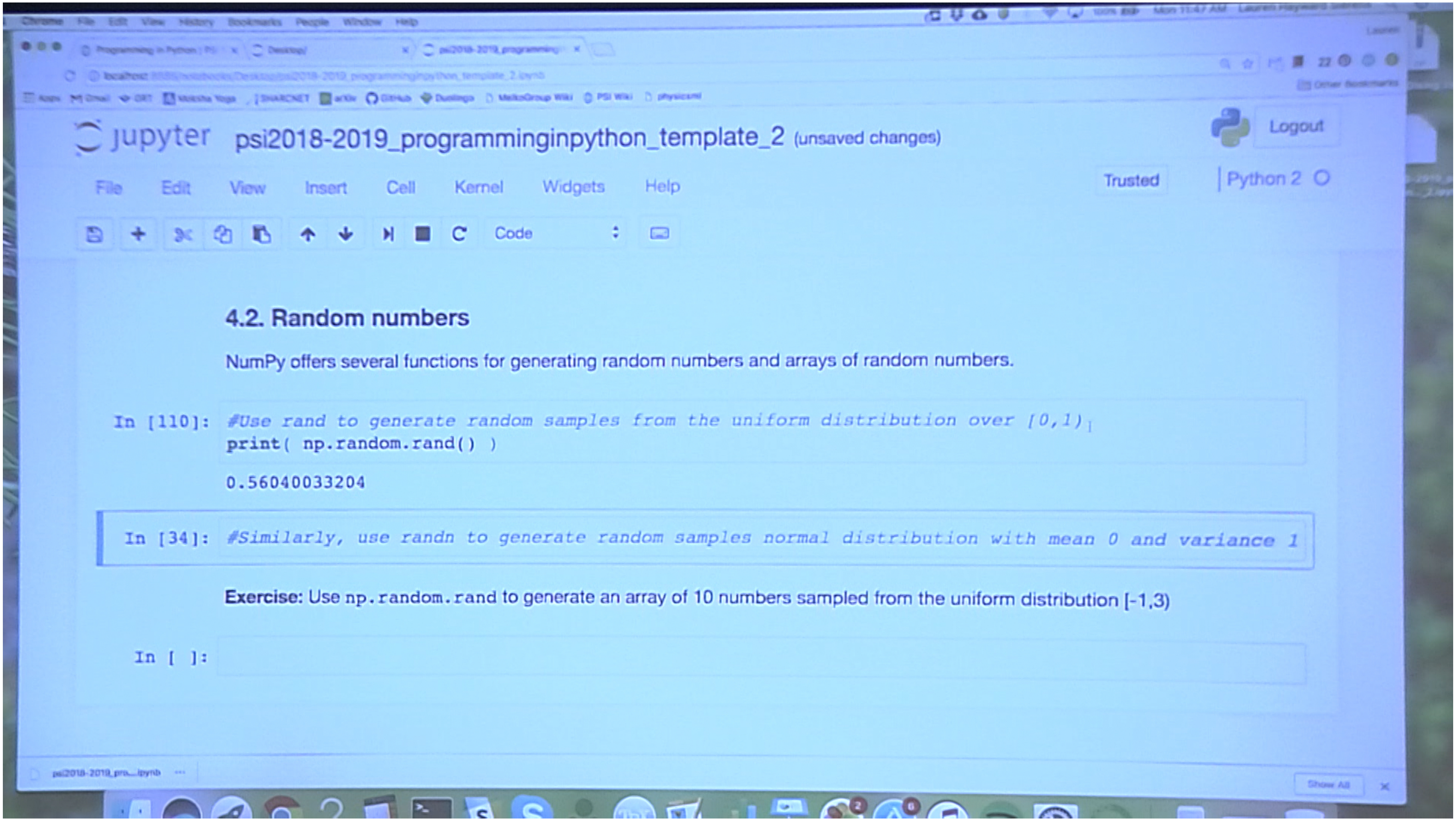
NumPy offers several functions for generating random numbers and arrays of random numbers.

In [33]:
```
#Use rand to generate random samples from the uniform distribution over [0,1)
```

In [34]:
```
#Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
```

Exercise: Use `np.random.rand` to generate an array of 10 numbers sampled from the uniform distribution [-1,3)

In [ ]: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4.2. Random numbers
NumPy offers several functions for generating random numbers and arrays of random numbers.
In [110]:
#Use rand to generate random samples from the uniform distribution over [0,1)
print(np.random.rand())
0.56040033204
In [34]:
#Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
Exercise: Use np.random.rand to generate an array of 10 numbers sampled from the uniform distribution [-1,3)
In [ ]:

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NumPy offers several functions for generating random numbers and arrays of random numbers.

In [113]:
```
#Use rand to generate random samples from the uniform distribution over [0,1)
print( np.random.rand() )
print( np.random.rand(5) )
print( np.random.rand(4,2) )
```

```
0.113822818921
[0.90273497 0.11473723 0.70942207 0.06108706 0.73449475]
[[0.12100888 0.70409352]
 [0.07289896 0.54196251]
 [0.92221933 0.60901518]
 [0.37251586 0.85721873]]
```

In [34]:
```
#Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
print( np.random.rand(5) )
```

Exercise: Use `np.random.rand` to generate an array of 10 numbers sampled from the uniform distribution [-1,3)

In [ ]:

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NumPy offers several functions for generating random numbers and arrays of random numbers.

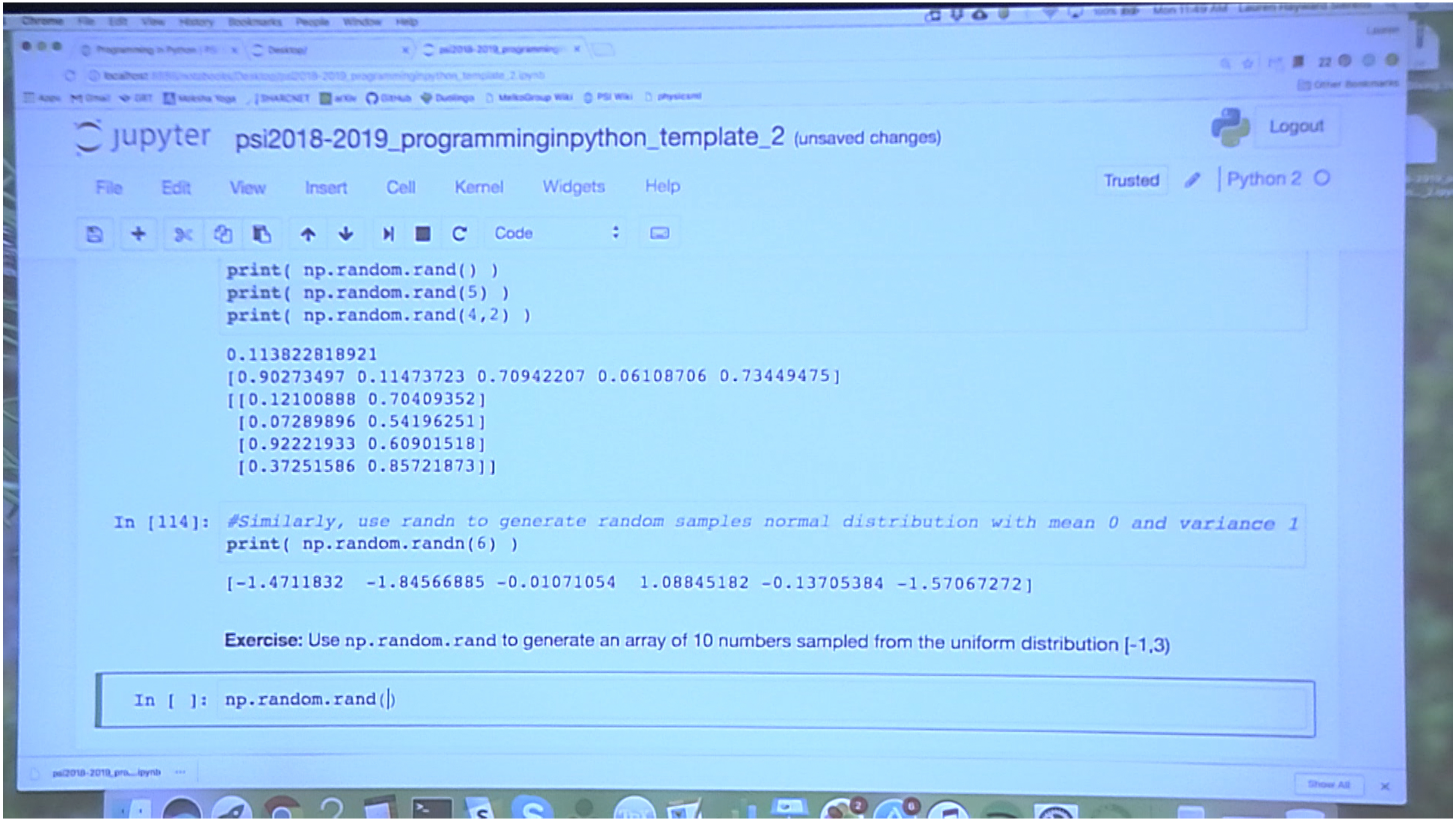
In [113]:
```python
#Use rand to generate random samples from the uniform distribution over [0,1)
print( np.random.rand() )
print( np.random.rand(5) )
print( np.random.rand(4,2) )
```

```
0.113822818921
[0.90273497 0.11473723 0.70942207 0.06108706 0.73449475]
[[0.12100888 0.70409352]
 [0.07289896 0.54196251]
 [0.92221933 0.60901518]
 [0.37251586 0.85721873]]
```

In [114]:
```python
#Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
print( np.random.randn(6) )
```

```
[-1.4711832  -1.84566885 -0.01071054  1.08845182 -0.13705384 -1.57067272]
```

Exercise: Use `np.random.rand` to generate an array of 10 numbers sampled from the uniform distribution [-1,3)



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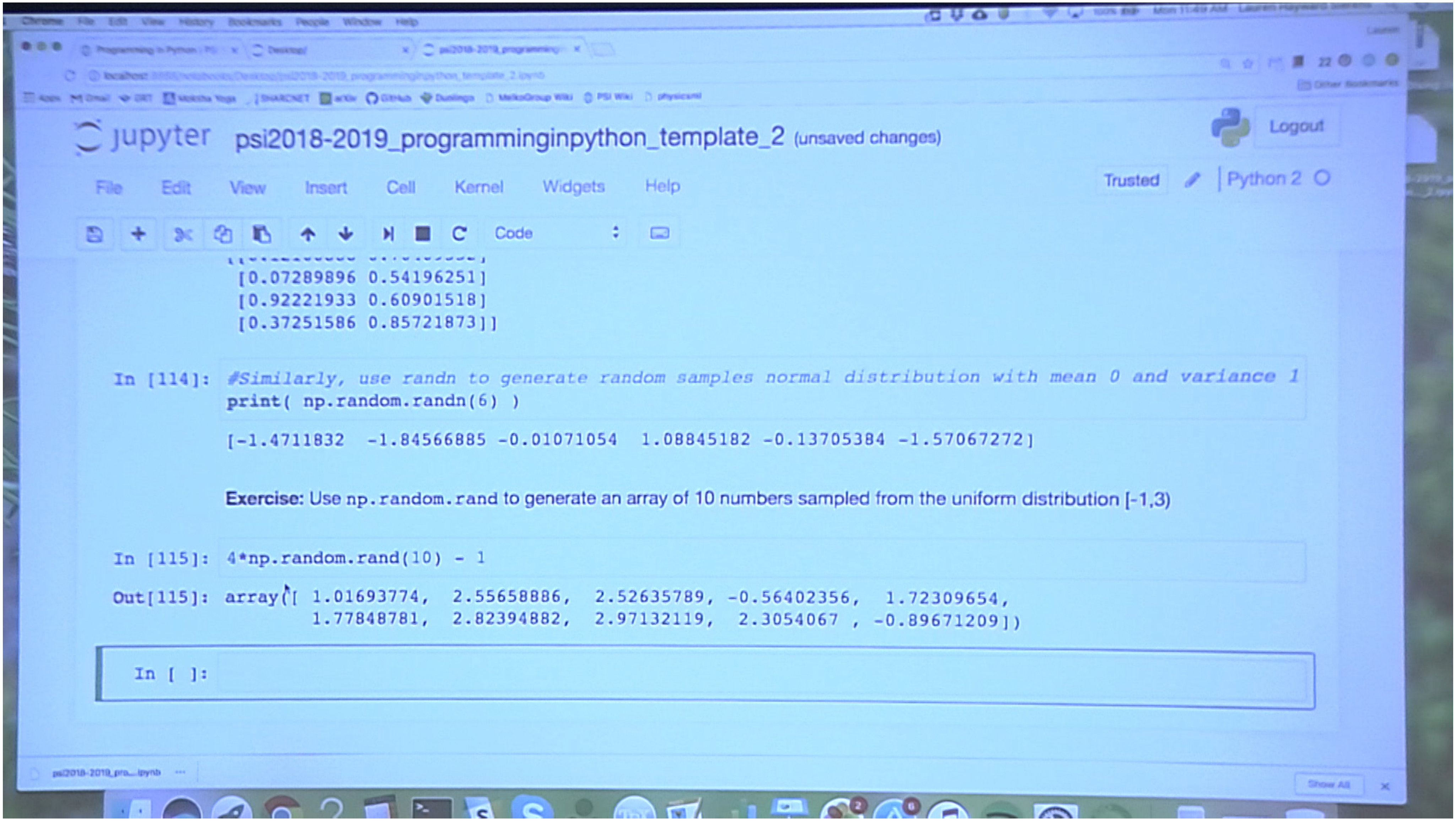
Code
print(np.random.rand())
print(np.random.rand(5))
print(np.random.rand(4,2))
0.113822818921
[0.90273497 0.11473723 0.70942207 0.06108706 0.73449475]
[[0.12100888 0.70409352]
[0.07289896 0.54196251]
[0.92221933 0.60901518]
[0.37251586 0.85721873]]
In [114]: #Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
print(np.random.randn(6))
[-1.4711832 -1.84566885 -0.01071054 1.08845182 -0.13705384 -1.57067272]
Exercise: Use np.random.rand to generate an array of 10 numbers sampled from the uniform distribution [-1,3)
In [ ]: np.random.rand()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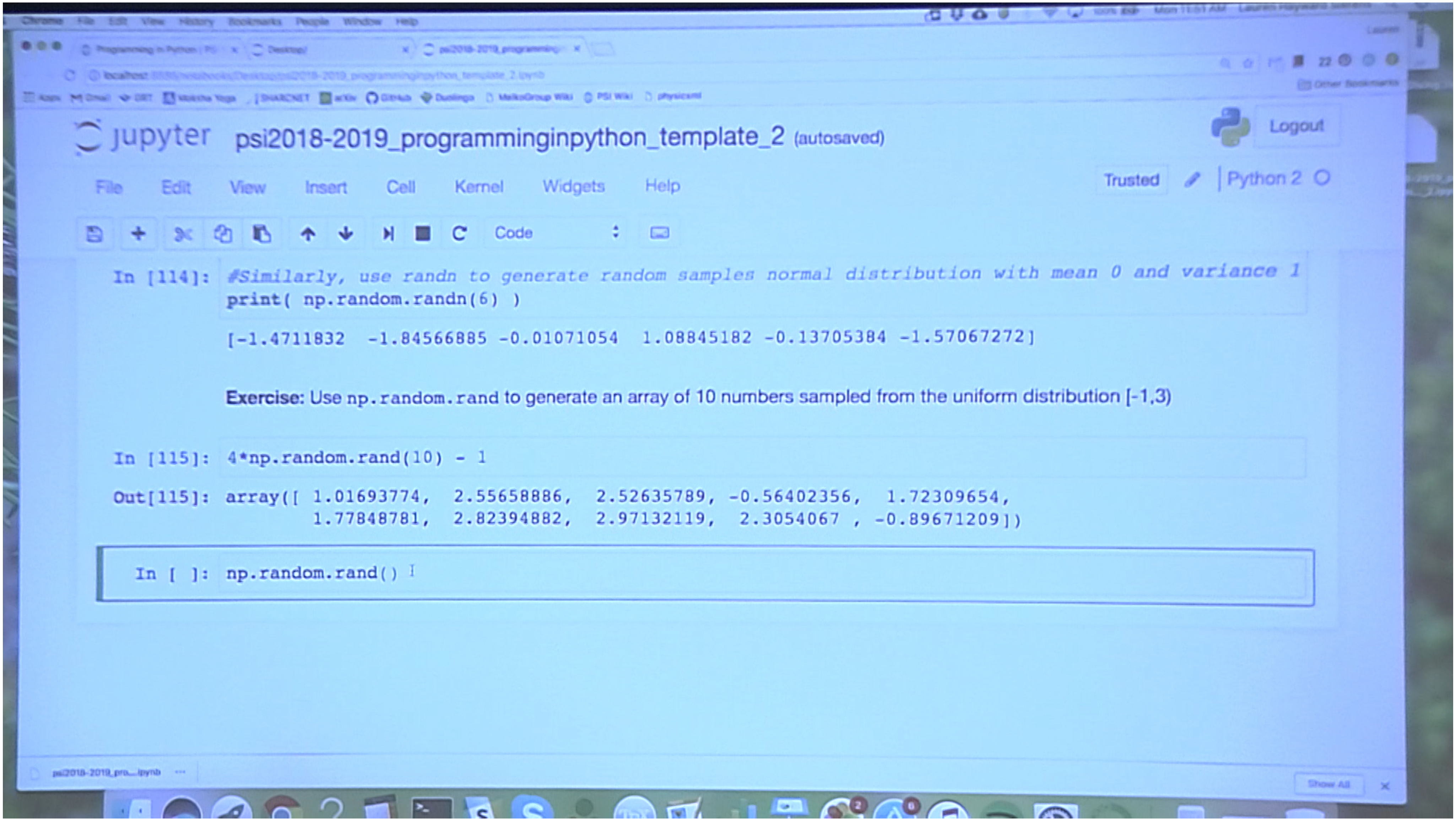
[0.07289896 0.54196251]
[0.92221933 0.60901518]
[0.37251586 0.85721873]]
In [114]: #Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
print(np.random.randn(6))
[-1.4711832 -1.84566885 -0.01071054 1.08845182 -0.13705384 -1.57067272]
Exercise: Use np.random.rand to generate an array of 10 numbers sampled from the uniform distribution [-1,3)
In [115]: 4*np.random.rand(10) - 1
Out[115]: array([1.01693774, 2.55658886, 2.52635789, -0.56402356, 1.72309654,
1.77848781, 2.82394882, 2.97132119, 2.3054067 , -0.89671209])
In [ ]: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Code
In [114]: #Similarly, use randn to generate random samples normal distribution with mean 0 and variance 1
print(np.random.randn(6))
[-1.4711832 -1.84566885 -0.01071054 1.08845182 -0.13705384 -1.57067272]
Exercise: Use np.random.rand to generate an array of 10 numbers sampled from the uniform distribution [-1,3)
In [115]: 4*np.random.rand(10) - 1
Out[115]: array([1.01693774, 2.55658886, 2.52635789, -0.56402356, 1.72309654,
1.77848781, 2.82394882, 2.97132119, 2.3054067 , -0.89671209])
In [ ]: np.random.rand()